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# CENTRAL ANGIOSPASTIC RETINOPATHY

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This report is concerned with a type of retinopathy which affects young or middle-aged adults, chiefly men, showing no generalized hypertension. It is seen almost exclusively when it affects the macular region and is characterized by symptoms and changes in the fundus which we believe can best be explained as the result of spastic contraction of the smaller retinal arterioles or capillaries supplying this region.

A search of the literature reveals little in the English language concerning the condition which we wish to consider. Temporary closure of the central retinal artery or one of its main branches, presumably due to spasm, is well known. It may affect young persons without other signs of vascular disease. A history of partial or complete unilateral blindness with complete recovery, which can hardly be explained on any other basis, is not uncommon. A few such cases have been seen while the artery was closed and again when it had refilled, but in such cases a permanent defect in the visual field usually remained. Crisp [1] reported this occurrence in a girl of 14; Halbertsma,[2] in a girl of 17, and Haïri,[3] in a woman of 23. Sédan and Jayle [4] in an extensive review of the subject listed a number of related cases, some of them associated with attacks of migraine. Esterman [5] saw a man of 42 fifteen minutes after closure of the central artery. Two hundred milligrams of sodium nitrite intravenously reduced the general blood pressure to 80 systolic and 60 diastolic. The vessels were seen to refill, and vision returned promptly to normal. In these cases no signs of vascular spasm were observed in other regions.

In a second group of cases closure of retinal arteries occurs in association with similar phenomena elsewhere in the body, especially in

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1. Crisp, W. H.: Am. J. Ophth. **4**:188, 1921.
2. Halbertsma, K. T. A.: Ann. d'ocul. **163**:641, 1926.
3. Haïri, H.: Ann. d'ocul. **163**:662, 1926.
4. Sédan, J., and Jayle, G. E.: Ann. d'ocul. **173**:609, 1936.
5. Esterman, B.: New York State J. Med. **37**:296, 1937; abstracted, Am. J. Ophth. **21**:711, 1938.

the extremities. Retinal lesions in patients with Raynaud's disease have been reviewed by Dunphy,[6] who reported a personal case. Such a case in a man of 39 was reported by Anderson and Gray.[7] Repeated changes in the caliber of the vessels were observed. The final result reported by W. M. and E. W. Carpenter[8] was total blindness in the affected eye, although the arteries in large part refilled. Gipner and Wagener[9] reported 2 instances of temporary closure in cases of Raynaud's disease in which the vessel was seen to refill during observation. They also observed 3 cases in which the closure was permanent.

Closure of retinal arteries has occasionally been observed in cases of thromboangiitis obliterans (Buerger's disease). Lisch[10] reported a case of permanent closure of the retinal arteries in a man of 33 with gangrene of the foot and characteristic changes in the capillaries as observed microscopically. Uyama[11] saw 2 cases of thromboangiitis obliterans in which there was complete closure of several branches of the central retinal artery. Sections in 1 case showed all the retinal arteries and veins to be much thickened, with complete occlusion in some branches. Marchesani[12] has seen recurring hemorrhages in the vitreous in cases of Buerger's disease, and his report aroused much discussion as to the frequency with which recurring hemorrhages in the vitreous of young men can be explained on this basis.

Photographic records of vascular spasm in the toxemia of pregnancy have been made abroad by Mylius[13] and in America by Freeman.[14] In these cases the event was part of the picture of general arterial constriction with hypertension. Refilling of the affected vessels, which were not completely closed, often occurred at the termination of pregnancy. Arterial spasm is known to play a part in the lesions of the fundus in essential hypertension and arteriosclerosis, as is shown by occasional instances of more or less complete recovery of vision after closure of the central artery or one of its branches.

The subject of this report is not closure of the larger arteries but the picture of central retinopathy which apparently results from constriction of a number of smaller vessels supplying the macular region.

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6. Dunphy, E. B.: Tr. Am. Ophth. Soc. **30**:420, 1932.
7. Anderson, R. G., and Gray, E. B.: Spasm of the Central Retinal Artery in Raynaud's Disease: Report of a Case, Arch. Ophth. **17**:662 (April) 1937.
8. Carpenter, W. M., and Carpenter, E. W.: Raynaud's Disease with Intermittent Spasm of the Retinal Artery and Veins: Follow-Up Report of a Case, Arch. Ophth. **19**:111 (Jan.) 1938.
9. Gipner, J. F., and Wagener, H. P.: Am. J. Ophth. **10**:650, 1927.
10. Lisch, K.: Klin. Monatsbl. f. Augenh. **99**:812, 1937.
11. Uyama, Y.: Arch. f. Ophth. **137**:438, 1937.
12. Marchesani, O.: Arch. f. Augenh. **109**:124, 1935.
13. Mylius, K.: Ztschr. f. Augenh. **77**:37, 1932.
14. Freeman, D.: Am. J. Ophth. **16**:341, 1933.

Batten [15] described as an acute primary macular disease a condition affecting young adults which tended to spontaneous quiescence with slight macular changes and little or no permanent decrease in vision. He believed it to be of septic origin. Various names have been given to conditions resembling this, with various theories as to the etiology. Von Graefe in 1866 described the condition as central recurrent retinitis and considered it due to syphilis. Hirschberg [16] described a similar case, as did E. Fuchs (1916), who suggested that the condition was due to a circulatory disturbance in the vessels about the macula, with syphilis as a probable predisposing cause.

In Japan Asayama described in 1898 a condition which he called retinitis centralis, which has since been seen with remarkable frequency in that country. Oguchi [17] reviewed the reports of six Japanese authors and reported a number of personal cases. He expressed the opinion that a pathologic process in the paranasal sinuses accounted for many cases and that the condition was an inflammatory one. Matsuoka, for example, collected reports of 640 cases during five years. The patients included 439 males and 201 females. The ages ranged from 30 to 50 years, and a positive scotoma and transient hyperopia were noted in all cases. Most patients recovered, with little if any permanent visual loss. Abe [18] reported 9 personal cases from Japan. He explained the hyperopia as due to retinal edema and not to paralysis of accommodation, as had been suggested. All his patients were men from 35 to 57 years of age. In the early stages the fundus showed nothing except a slightly darker hue in the macular region and disappearance of the foveal reflex. Later, fine white or yellowish spots appeared in the macular region.

Kitahara [19] collected more than 150 personal cases. He stressed micropsia and hyperopia as early symptoms. The fundus showed edema of the macula with a peculiar ring-shaped light reflex around the affected area. He explained this as due to a collection of subretinal fluid which elevates the macular area of the retina. After three or four weeks white punctate deposits appeared in all but 1 case. Most of these disappeared as the edema subsided, but a few larger ones persisted and became surrounded by fine deposits of pigment. In 1 case minute hemorrhages were seen about the macular area. Quiescence occurred usually in from two to three months, but recurrences were common, 1 patient having had fourteen during three years. Men were twice as often affected as women, the average age of affected persons being 40. Evidence of tuberculosis was found in 32.5 per cent of cases, and this was con-

15. Batten, R. D.: Tr. Ophth. Soc. U. Kingdom **41**:411, 1921.
16. Hirschberg, cited by Junius, P.: Ztschr. f. Augenh. **70**:129, 1930.
17. Oguchi, C.: Arch. f. Ophth. **110**:25, 1922.
18. Abe, T.: Klin. Monatsbl. f. Augenh. **83**:55, 1929.
19. Kitahara, S.: Klin. Monatsbl. f. Augenh. **97**:345, 1936.

sidered to be the cause in the majority of instances. In 7 cases in which entoptoscopic examination was done, findings similar to those in Horniker's cases, which will be described, were noted, but Kitahara considered the circulatory disturbance indicated by this method as secondary to edema and not the cause of it.

Under the name preretinal edema, Guist [20] reported 5 cases which seem to fall definitely into the group considered here. He explained the peculiar ring-shaped reflexes which were seen with the Gullstrand ophthalmoscope as due to fluid between the inner surface of the retina and the vitreous. He considered the condition inflammatory and probably of tuberculous origin. Slight pigmentation of the macula and moderate reduction of vision resulted in several cases. Gissy [21] reported a similar case in which fine opacities of the vitreous appeared suddenly when the edema disappeared, as if a membrane retaining the preretinal fluid had ruptured.

Aside from the brief report of Batten, the only reference to this clinical picture available in the British and the American literature is a report by Walsh and Sloan.[22] They reported 3 cases, all in men from 35 to 40 years of age, which were identical in nearly all respects with those just described. All the patients recovered normal vision. In 1 the fundus became normal; in 1 yellowish spots appeared, while in the third some displacement of pigment persisted in the macula. They noted in all cases a reduplication of the fine beam of the Friedenwald ophthalmoscope when this was focused on the retina, indicating a collection of fluid between the retina and the choroid. Because of this, they called the condition idiopathic flat detachment of the macula. In 2 cases removal of foci of infection preceded subsidence of the edema, while in the third case no treatment was given. Two of the patients were smokers. They expressed the belief that the condition probably results from toxins reaching the retina through the blood stream, although a circulatory disturbance was also suggested as a possible cause.

In the previously mentioned cases of macular disease, aside from the suggestion by E. Fuchs of a circulatory disturbance, little attention was paid to the appearance of the retinal vessels, the condition being usually considered of an inflammatory nature. Kraupa,[23] however, in 1923 described 2 cases similar to those of Guist under the name retinitis centralis annularis, which he attributed definitely to retinal ischemia resulting from changes in the capillaries. No evidence for an infectious

20. Guist, G.: Ztschr. f. Augenh. **54**:37, 1925; **55**:269, 1925.

21. Gissy, C. J.: Ztschr. f. Augenh. **57**:423, 1925.

22. Walsh, F. B., and Sloan, L. L.: Am. J. Ophth. **19**:195, 1936.

23. Kraupa, E.: Ztschr. f. Augenh. **50**:335, 1923.

origin could be found. It remained for Horniker [24] to collect a considerable number of cases in which general and special examinations afforded evidence of vasomotor instability and to suggest for this group the name central angiospastic retinitis. His first group of 8 cases was reported in 1927, followed in 1929 by 10 cases and in 1937 by 24 additional cases. The ocular symptoms and changes in the fundus were identical with those described by the Japanese observers. In cases in the early stage almost no changes in the fundus were seen by ordinary ophthalmoscopic examination, but with red-free light edema of the macula, often with a ring-reflex about the region, could be observed. Later, dots varying from a yellowish color to white appeared, which Horniker considered identical with Gunn's dots. Retinal hemorrhages were observed in only 1 of the first 18 cases. Later, in many cases small areas of atrophy and pigmentation appeared which seemed to be permanent. Recurrences were observed in 11 of the first 18 cases, but the visual outcome was, as a rule, good. The small vessels, both arteries and veins, were very tortuous and extended further toward the macula than in normal fundi. In 3 cases changes in the larger vessels were seen, including segmental narrowing in 1, which disappeared later. The age at which the condition was seen varied from 23 to 59 but was most commonly from 35 to 42. Men were chiefly, but not exclusively, affected. The systemic blood pressure was slightly increased in many cases, averaging from 150 to 125 systolic, but a number of young adults with normal blood pressure were affected. A history of other vasomotor disturbances was given in nearly all cases, and this evidence of the "angioneurotic diathesis" was confirmed, in the author's opinion, by the method of entoptoscopy. With this examination, previously described by Scheerer, the patient observes subjectively the movement of shiny particles, presumably in the retinal vessels, against a special lighting arrangement. A patient with "angioneurosis" notes a slowing of the movement, an absence of pulsation and often an enlargement of the central area which is free from particles, which is supposed to correspond with the avascular macula (Maxwell's spot). Other ocular signs considered characteristic of the angioneurotic diathesis were punctate peripheral opacities of the lens and hyaline bodies on Descemet's membrane. Horniker concluded that the picture is best explained as the result of ischemia produced by functional narrowing of the finer retinal arterioles or capillaries. As precipitating factors, he emphasized psychic disturbances, exposure to cold and, in a few cases, exposure to excessive light. He expressed the belief that the condition is more common than is generally believed and includes the cases described as central retinitis

24. Horniker, E.: Ann. di ottal. e clin. ocul. **55**:55, 1927; Arch. f. Ophth. **123**: 286, 1929; Klin. Monatsbl. f. Augenh. **98**:487, 1937.

by the Japanese. He found evidence of tuberculosis in few of his patients and was of the opinion that both syphilis and tuberculosis, when they exist, act only as contributing factors in persons with vasoneurotic diathesis. His method of treatment, based on an attempt to relax peripheral vascular spasm and including the administration of papaverine, atropine by mouth, the barbiturates and calcium, was usually successful in shortening attacks and reducing the frequency and severity of recurrences.

Bailliart [25] devoted much time to a study of retinal lesions due to changes in the finer vessels. In an article on capillaritis and lacunar lesions of the retina he reviewed a number of conditions which he believed must be explained on this basis. Basing his conclusions particularly on the histologic study of Morax in a case of circinate retinitis, he concluded that the white spots seen in this and in a group of allied conditions are due to ischemia of isolated areas following closure of the capillaries, with the deposit of lipoid material to replace the degenerated cells. He included among these conditions circinate retinitis and senile macular degeneration as grouped forms and the occurrence of such "lacunar lesions" in various parts of the retina as a diffuse form. Most ophthalmologists would not agree with him or with Horniker that Gunn's dots and hyaline deposits of the lamina vitrea *(Drusen)* are to be explained on the same basis. Bailliart mentioned also the occurrence of functional spasm affecting the macular region in young persons with normal blood pressure, and in a later article on retinal edema he devoted more attention to the type of case described by Horniker. He emphasized the beneficial effect of vasodilators, especially acetylcholine, in such conditions. Héry,[26] a pupil of Bailliart, reviewed more completely the evidence for Bailliart's views and reported a number of cases, chiefly in older persons with hypertension. For treatment, besides acetylcholine, he recommended an insulin-free pancreatic extract. Cattaneo [27] under the title "The Angiosclerotic and Angiospastic Retinoses" attempted to classify a number of retinal conditions in a manner similar to that of Bailliart. He reported 17 cases in which the small lesions of capillarosis were combined with changes in the larger vessels.

For the sake of completeness, a few reports of single cases or of small groups of cases may be mentioned. Junius,[28] under the title "Juvenile Exudative Macular Retinitis," reported 5 cases. Three of these cases seemed to fall into the classification considered here, as the affected persons were from 28 to 34 years of age, and complete or almost com-

25. Bailliart, P.: Ann. d'ocul. **171**:97, 1934; **175**:133, 1938.

26. Héry, J.: Certain lésions du fond d'oeil d'origine capillaire, Thesis, Paris, Librairie E. Le François, 1935.

27. Cattaneo, D.: Ann. di ottal. e clin. ocul. **65**:721, 1937.

28. Junius, P.: Ztschr. f. Augenh. **70**:129, 1930.

plete recovery resulted. Stern [29] reported 3 cases of central retinitis in which entoptoscopic examination revealed evidence indicative of the vasoneurotic diathesis. Suganuma [30] reported 5 cases of angiospastic retinal opacity in young adults affecting the upper or lower half of the retina but sparing the fovea. The affected vessels filled, but permanent defects in the visual field remained. The condition in these cases resembled that in the cases cited earlier in this report in which larger vessels were affected. Kiewe and Reh [31] reported a case in which rapid disappearance of central retinal edema followed removal of an infected tooth. Zeeman [32] reported 3 cases which he recognized as falling into the group described by Horniker. Riehm [33] reported 3 cases of chorioiditis centralis serosa in men 30, 31 and 35 years of age in which the picture was identical with that described by Kitahara. A flat detachment of the macular region was made out in all cases. He considered the condition due to inflammation in the choroid, probably on a tuberculous basis.

As is apparent from this review, little attention has been paid to functional changes in the smaller retinal vessels in considering cases of central retinopathy. In spite of the suggestions of E. Fuchs and Kraupa that a circulatory disturbance was probably responsible for the condition, no attempt was made to study a group of cases from the vascular standpoint until the work of Horniker. Since his reports, Bailliart, Héry and Cattaneo have approached the subject from this point of view. None of these authors availed themselves of certain modern methods of examination which are now considered essential in the diagnosis of peripheral vascular disease. Such examinations were carried out in 5 of the 7 cases which we wish to report.

In such cases, besides the usual physical and serologic examinations, a careful history with respect to subjective symptoms of coldness and paresthesias of the extremities is considered important. Observation that the hands or feet blanch in cold weather or after washing in cold water is suggestive of peripheral angiospasm. On inspection, the general nutrition of the skin and muscles and the color of the skin are noted. Trophic changes are uncommon in cases of recent angiospasm, but usually there is flushing of the extremities when they are in the dependent position and pallor when they are elevated. The temperature of the skin is recorded after the patient has remained in a draft-free

29. Stern, H.: Ztschr. f. Augenh. **79**:361, 1933.

30. Suganuma, S.: Acta Soc. ophth. jap. **41**:1557, 1937; abstracted, Klin. Monatsbl. f. Augenh. **100**:304, 1938.

31. Kiewe, P., and Reh, J.: Klin. Monatsbl. f. Augenh. **96**:448, 1936.

32. Zeeman, W. P. C.: Klin. Monatsbl. f. Augenh. **87**:548, 1931.

33. Riehm: Klin. Monatsbl. f. Augenh. **100**:617, 1938.

room for one hour. The temperature of the extremities should not vary more than 4 or 6 degrees C. (7.2 or 10.8 degrees F.) from that of the abdomen. Temperature readings lower than this amount speak for a deficiency of arterial blood. When such readings are found, blocking of the tibial nerve with 2 per cent solution of procaine hydrochloride causes relaxation of the arterial walls with an increase in temperature of points distal to the block. Such blocking will cause a rise of about 2 degrees C. (3.6 degrees F.) in normal extremities, while in persons with angiospasm, as will be seen in some of our cases, the rise is considerably greater. In smokers, the effect of smoking on the temperature of the extremities is sometimes striking, as illustrated in our cases 2, 4, 5, 6 and 8.

Oscillometry affords another direct method for measurement of the filling of peripheral arteries. Decreased oscillometric readings indicate decreased arterial flow, while repeated readings during treatment afford a definite indication of its effect. The "flare" produced by the intradermal injection of minute amounts of histamine is in direct proportion to arterial flow and is used as a further check.

Capillary microscopy of the bed of the toe nail or finger nail affords a convenient means of studying the peripheral circulation. In persons with angiospastic disease the number of visible capillaries is decreased by 30 to 40 per cent. Those which are visible are markedly diminished in caliber and show the phenomenon of "plasma-skimming" in which segments of the capillary are empty of red cells, while closely packed cells are seen in the portion of the loop proximal to the narrowed portion. When peripheral spasm is relaxed, more capillary loops are visible and the areas of plasma-skinning become less numerous.

The results of such examinations in our cases, where they were carried out, are shown in the accompanying table. In 2 cases the examination was not made until some time after the ocular condition had become quiescent, while in the others it was made during the period of activity and was repeated, when possible, after quiescence had occurred. The Wassermann reaction was negative in all cases, and none of the patients showed evidence of tuberculosis. Other details are included in the individual histories.

## REPORT OF CASES

The cases may be divided into two groups. In the first 6 cases the typical picture of central retinopathy without involvement of larger retinal vessels was present. In the last 2 cases involvement of larger vessels was observed. It is unfortunate that the importance of the special examinations was not realized when the patients were seen in the early stages of the condition.

*Results of Special Examinations in the Reported Cases*

| Case No. | Nationality, Occupation, Age | Blood Pressure, Average | Oscillometric Data on Ankle: Before Treatment | Oscillometric Data on Ankle: After Treatment | Temperature of Toes Before Nerve Block | Temperature of Toes After Nerve Block | Time of Observation | Treatment | Acrocyanosis of Toes | Reaction After One Cigaret | Capillary Spasm,* Basis + to 4+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Italian Salesman 33 | 118/80 | 3.0+ | 3.0+ | 32 C. (89.6 F.) | 34 C. (93.5 F.) | 3 yr. | Stopped smoking; phenobarbital | .... | Drop of 4.6 degrees C. (8.2 degrees F.) after 1 cigaret | ++++ |
| 4 | Jewish Lawyer 31 | 124/80 2/20/38 | 2.0 | 3.0+ | 28.6 C. (83.4 F.) | 32.4 C. (90.3 F.) | 10 mo. | Tissue extract; phenobarbital; thyroid extract; stopped use of tobacco | ++ | Drop of 4 degrees C. (7.2 degrees F.) six minutes after 1 cigaret | ++ |
| 5 | Irish Druggist 41 | 130/80 | 1.5 | ... | 27.4 C. (81.3 F.) | 33.2 C. (91.7 F.) | 2 wk. | Stopped smoking; phenobarbital | ++ | Drop of 5 degrees C. (9 degrees F.) after 1 cigaret | ++++ |
| 6 | Jewish Dentist 34 | 120/70 | 2.0 | 2.0 | 33 C. (91.4 F.) | 35.2 C. (95.3 F.) | 6 wk. | Stopped smoking; phenobarbital; typhoid vaccine intravenously; tissue extract | + | Drop of 3.2 degrees C. (6.7 degrees F.) after 1 cigaret | ++ |
| 7 | American Messenger 23 | 144/90-104/68 Low reading after nitrite therapy | 1.5 | 3.0+ | 25 C. (77 F.) | 31.2 C. (88.1 F.) | 1 yr. | Nitrites; tissue extract; typhoid vaccine intravenously; treated 6 days; stopped smoking | ++ | Formerly smoked; drop not measured | ++++ |
| 8 | German Salesman 38 | 128/82 | 1.0+ | 3.0+ | 29.2 C. (84.5 F.) | 32.8 C. (91 F.) | 14 mo. | Tissue extract; phenobarbital for six months; stopped smoking | ++++ | Drop of 4.6 degrees C. five minutes after 1 cigaret | ++++ |

* Observations by capillary microscopy.

## REPORT OF CASES

CASE 1.—Robert G. aged 43, was first seen on July 24, 1931. He had noticed a spot before the left eye two months before and stated that vision in this eye was very poor. Tonsillectomy was performed, and two weeks later vision improved markedly. He was still conscious of a positive scotoma, however, Five months previously he had noted almost complete loss of vision in the same eye for two or three hours, with prompt return to normal. At the first examination vision was 20/13—2 in each eye, but the letters were not so clearly seen with the left eye. The peripheral fields were normal, and tension was 19 mm. (Schiötz) in each eye. The left macular region showed a coarse granular appearance. Below and temporal to the macula were a few faint white deposits deep to the retinal vessels. The veins showed slight indentation by arteries of normal size and appearance. The patient's physician reported that the general blood pressure was low. Physical examination otherwise gave negative results. The patient is an executive who works under high pressure, drinks three highballs a day and smokes very little.

Three months later he reported that vision with left eye had been worse for the past few days. Vision recorded was as 20/13 in the right eye and 20/15 — 3 (not clear) in the left eye. The central fields showed a small central scotoma for colors and slight enlargement of the blindspot. The left macula appeared congested, and with red-free light peculiar circular reflexes were seen about it which were not present in the right eye. Two months later vision was worse in the left eye (20/30—2), and a larger scotoma for green was present. The picture of the fundus was unchanged. The patient was given 1 grain (0.6 Gm.) of sodium nitrite three times a day and advised as to hygiene and rest. One month later vision was 20/20—2 in the left eye, and the scotoma was smaller. In March 1932 vision was 20/15 in each eye. The improvement had occurred following a vacation, and since resuming hard work the patient had noticed slight blurring of vision again. The left macula showed no abnormal reflexes but had a more definitely coarse granular appearance.

CASE 2.—Mr. F. T., aged 30, had noted blurring of vision in the left eye for the past two months. When he was first seen on March 13, 1935, vision in the right eye was 20/15 and the in the left eye 20/15 + 2, with improvement to 20/15 with a —0.75 cylinder. Two days later it was 20/25 in the left eye, with no improvement with correction. The only objective finding was a small, sharply demarcated area just above the center of the macula which was much redder than the surrounding region and which was not present in the right eye. The foveal reflex was absent. About the red area was a small amount of fine granular pigment. A small relative central scotoma was present. General examination, including a Wassermann test of the blood and roentgenograms of the teeth and paranasal sinuses, gave negative results. The blood pressure was 118 systolic and 70 diastolic. The patient was given one intravenous injection of typhoid vaccine with moderate febrile reaction and amyl nitrite twice a day. Special examinations of the peripheral vascular system were not made at this time. When they were made later, however, three years after the first attack, definite signs of peripheral vascular constriction were present, as recorded in the table.

Twelve days later vision was 20/15 (partly), and the scotoma had cleared in the center, remaining just below the fixation point (fig. 1). The red area first seen had disappeared, while the granular pigment about it was more definitely visible. Three weeks later the condition was unchanged, but on June 16, three months after the first visit, vision in the left eye was again reduced to 20/15—2. The

left fundus showed a red area in the lower part of the fovea, above which the retina was gray with barely visible reflexes, indicating folds. The gray area had a sharply reflecting edge separating it from the red foveal area. The patient was put on sodium nitrite, instructed as to a more restful hygiene and ordered to discontinue smoking. A month later vision had improved slightly. Fine shiny crystals had begun to appear in the retina just above the fovea. Three months later (October 1935) vision was 20/15, and the fundus picture was about the same. The red spot was present and appeared depressed, so as to resemble a senile macular hole, except that the edges were not sharply defined. On July 5, 1938, the fundus picture was the same. Vision was 20/15, but the patient was still conscious of a central visual defect. The results of special examinations made in July 1938 are shown in the table.

CASE 3.—Albert B., aged 17, was seen on May 17, 1937, in consultation with Dr. Dora B. Olkon. The boy had myopia of about 5 diopters, and his vision and refraction had been known to Dr. Olkon for a number of years. At an examination six months before, vision was 20/20 in each eye with correction. Two days before this visit he had noticed blurring of vision in the right eye.

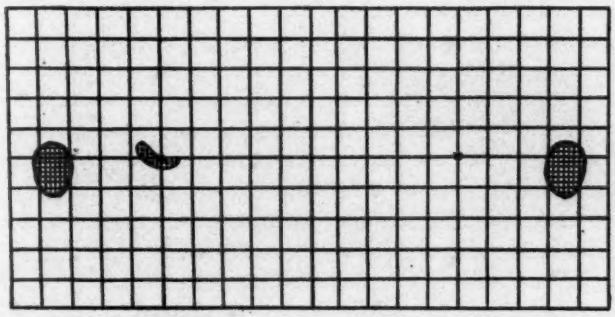

Fig. 1 (case 2).—Visual fields taken on April 22, 1935, with a 1 mm. test object at 1,000 mm.

Vision was reduced to 20/200, with no improvement with correction. By ordinary ophthalmoscopic examination the fundus appeared normal, but with the Friedenwald ophthalmoscope the area immediately about the fovea was seen to be slightly raised, and abnormal reflexes suggesting folds were seen on its surface. Nothing abnormal was seen about the retinal vessels. Three days later vision was 20/40 with correction, and five days later it was 20/25. After two months vision was 20/20 with the old correction, and the fundus was normal. Physical examination at this time gave negative results. There has been no recurrence of the visual disturbance during the subsequent year. The results of special examinations made a year after the attack are given in the table.

CASE 4.—Louis K., aged 31, is the first patient with typical retinopathy who was seen from the onset of symptoms and on whom the complete special examination could be performed during and after the attack. He had been under observation by one of us for refraction for six years before the onset of the present trouble. Six months before, vision was 20/15 in each eye with correction for a moderate grade of myopia and myopic astigmatism, which had not increased during five years. On March 7, 1938, he came in complaining of a faint veil before the right eye and of tenderness of the left eye for the past twenty-four

hours. Vision was 20/15 in each eye with his correction. The central visual fields showed small paracentral scotomas for a 1 mm. white test object at 1,000 mm. (fig. 2). The right fundus showed a small moth-eaten area in the deeper

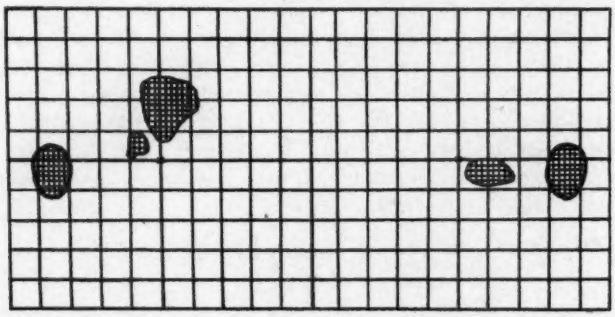

Fig. 2 (case 4).—Visual fields taken on March 7, 1938, with a 1 mm. test object at 1,000 mm.

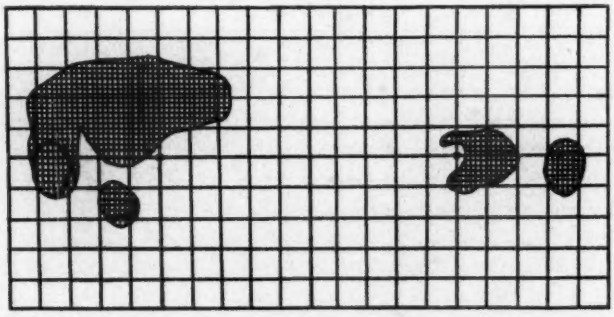

Fig. 3 (case 4).—Visual fields taken on March 17, 1938, with a 1 mm. test object at 1,000 mm.

Fig. 4 (case 4).—Fundus picture.

retinal layers just up and in from the macula. Some fine tortuous vessels were seen coming quite far into the macular region above and below. The left fundus showed a minute fresh hemorrhage in the nerve fiber layer. The fine vessels were tortuous and varied in caliber. The condition was unchanged two days later, while after four days a second hemorrhage was seen just below the left fovea,

the one previously observed having disappeared. The general condition revealed nothing abnormal by the usual methods of examination. The brachial blood pressure was 130 systolic and 70 diastolic. The patient was given nitrites after the second visit and six daily injections of 0.2 Gm. of acetylcholine. A week after his first visit the scotomas had enlarged, though vision was still 20/15 in each eye. In the right fundus a larger light area was present up and in from the macula, suggesting absorption of the pigment epithelium. The left fundus showed a light area above the macula, which was seen to be slightly raised with the Friedenwald ophthalmoscope and was interpreted as an area of edema. The patient was hospitalized for special tests, with the findings shown in the table. On antispasmodic treatment the scotomas, which had enlarged by March 17 (fig. 3), began to decrease in size and were less noticeable to the patient. The fundi showed a gradual development of pigment deep in the retina at the site of the lesion previously described. The light area in the right fundus became larger, extending down between the nerve and the macula, with pigment about its borders. Pigment appeared about the macula in the left fundus (fig. 4) and became more pronounced in the right fundus, while the scotomas continued to decrease in size. The patient gained 30 pounds (13.6 Kg.) during three months of observation.

Case 5.—Mr. F., aged 41, was first seen on June 8, 1938. For the past year he had noticed distortion of objects seen with the left eye and an apparent increase in their size. The amount of disturbance had varied greatly from time to time. Vision with his correction was 20/13 in the right eye. Vision in the left eye was $20/20 + 2$, with slight improvement with the addition of a $+ 0.75$ cylinder. A small central scotoma for a 1 mm. white test object at 1,000 mm. was present. The left fundus showed a coarse granular appearance in a small area of the macular region. Some coarse pigment was present, and the choroidal vessels were visible in a number of small areas. The larger vessels appeared normal. Five tortuous veins extended far into the macular region. With the Friedenwald ophthalmoscope a faintly opaque tissue was seen veiling the vessels in this region, and there were also a number of fine lines, suggesting folds in the inner limiting membrane. The foveal reflex was absent. The condition was the same three weeks later. Findings of the special examinations made at this time are seen in the table.

Case 6.—Dr. K., aged 40, was referred by Dr. A. H. Jenkins on July 28, 1938, following sudden loss of vision in the right eye. When seen by us one week after the onset of symptoms, vision was 20/200 in the right eye, with no improvement with correction, and 20/15 in the left eye. The central visual fields showed a large absolute central scotoma in the right eye for a 7 mm. test object at 1,000 mm. The right fundus showed edema of the macular region. With the fine beam of the Friedenwald ophthalmoscope the retinal surface in this region was seen to be distinctly elevated. A circular light reflex, not quite complete, surrounded the macular area. The retinal veins were large. The lower temporal artery as it left the disk was much constricted, but became normal in size after passing the first arteriovenous crossing. Several other arterial branches narrowed rapidly a short distance from the disk. The results of the general examination and of the special examinations of the peripheral vessels were negative, except for a marked drop in the temperature of the extremities after smoking, as shown in the table. The patient smoked five or six cigars a day and did not use alcohol. He was given one intravenous injection of typhoid vaccine and twenty intra-

muscular injections of insulin-free pancreatic extract and discontinued smoking. Small doses of phenobarbital were employed for several weeks. One week later vision in the right eye had returned to 20/25. Most of the retinal edema had disappeared, though a slight veiling of the macula was still present. One month later Dr. Jenkins reported that vision was 20/15 and that the fundus was normal, the constriction of the lower temporal artery having disappeared. Medication had been discontinued, but abstinence from tobacco was being maintained.

In the following 2 cases, while the macular regions were involved, changes were also present in the larger retinal vessels.

CASE 7.—Joseph C., aged 23, was seen on Dec. 30, 1936. Five years before he had noted a floating cloudlike shadow before the right eye. Vision had decreased gradually, until after several months central vision was lost. The condition in this eye had appeared to him to be stationary since that time. Four weeks before the date of his visit he noted dimness in the upper portion of the left visual field. Vision returned in this area, while the lower field became similarly affected. There had been some pain about the left eye, especially on movement. Vision was 10/70

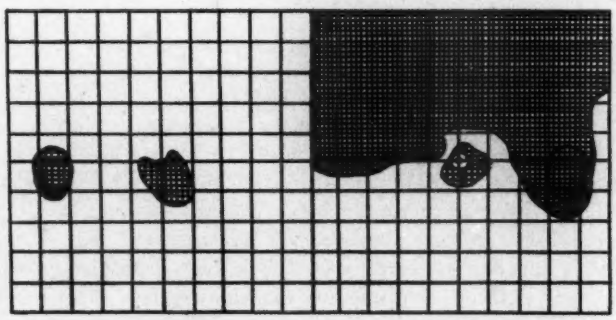

Fig. 5 (case 7).—Visual fields taken on Dec. 31, 1936, with a 2 mm. test object at 1,000 mm. Vision was 10/70 in the right eye and 20/70 in the left eye.

in the right eye and 20/70 in the left eye. The left visual field showed a loss of most of the upper portion, while the right showed a central scotoma (fig. 5). There were a large central area of chorioretinal atrophy and displacement of pigment in the right fundus.

The large vessels were normal, except for some white sheathing near the disk. The left fundus showed marked edema of the retina above the disk, with white deposits radiating from the macula and a larger white deposit below the disk with three small hemorrhages about it. The superior and inferior temporal arteries were small but contained blood. The corresponding veins showed a peculiar beaded appearance, indicating almost complete stasis.

The history was irrelevant, and the usual general examination gave essentially negative results. Special examination of the peripheral vascular system gave the findings seen in the table.

The patient was given large doses of calcium lactate, four intravenous injections of typhoid vaccine and after a few days, small doses of sodium nitrite. During the next two weeks the edema of the left retina cleared rapidly, and vision improved to 15/20. During the next two months the patient was given twenty-four injections of an insulin-free pancreatic extract and stopped smoking. Four

months later vision was 20/100—1 in the right eye and 20/20 + 3 in the left eye. The right fundus was unchanged, while the left showed the same contraction of the previously affected arteries and slight pallor of the disk. A 20 per cent improvement in peripheral circulation was noted on repetition of the special tests.

When the patient was seen in August 1938, vision and the visual fields were the same as in June 1937, and the fundi were unchanged. Special examinations showed findings considered to be within normal limits, as shown in the table. The patient had continued abstinence from tobacco and had received no medication for one year.

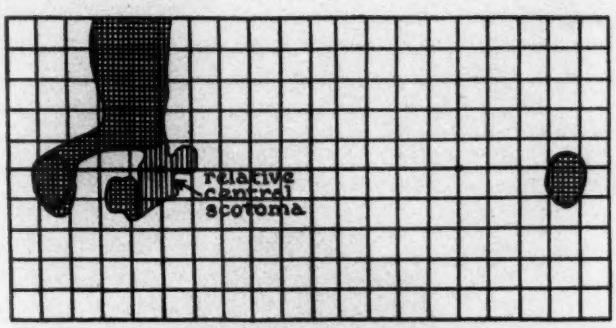


Fig. 6 (case 8).—Visual fields taken on Jan. 1, 1938, with a 1 mm. test object at 1,000 mm.

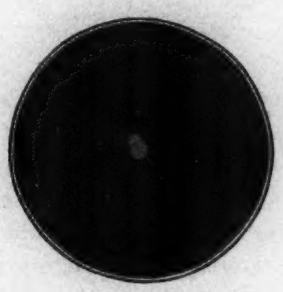

Fig. 7 (case 8).—Right fundus.

CASE 8.—Frank S., aged 37, was first seen Jan. 12, 1937. Six months before he had noted blurred vision in the left eye. The vision became worse in spite of treatment, and soon the right eye was similarly affected. Later vision on the right had cleared, but vision in the left eye never returned to normal. During the last few days vision in the left eye had become worse. General examination at the Mayo Clinic and elsewhere gave essentially negative results except for a chronic prostatitis. The patient used a moderate amount of alcohol and tobacco. He stated that the blood pressure had always been found normal.

At his first visit vision was 20/13 in the right eye and 20/25 in the left eye, there being no improvement with correction. The central visual fields are shown in figure 6. The right fundus showed a small linear hemorrhage near the upper temporal artery (fig. 7). The arteries were of normal size as they left the disk but became small rapidly. Arteriovenous compression was noted at all of the crossings.

In the left eye the rapid narrowing of the arteries was even more marked, the lower nasal artery being especially small. The macular region showed much fine granular pigment mixed with shiny white deposits. Special examinations showed the findings given in the table.

On antispasmodic treatment and treatment for prostatitis the vision remained unchanged after two months. It was our impression that the retinal arteries were somewhat larger, but this could not be confirmed by photography. The hemorrhage in the right fundus absorbed promptly, and no other hemorrhages were ever observed. The condition was unchanged on May 18, 1937. In August 1937 vision was reduced to 20/40 in the left eye, while that in the right remained 20/13. The fundus picture was unchanged. Antispasmodic treatment, which had been discontinued, was resumed. Four months later vision in the left eye was 20/30 —3. The patient stated that it had returned to normal one month after the last visit but two days before this visit had shown a sudden decrease. The patient had seen Dr. John Wheeler in the meanwhile, who agreed with our opinion as to a vascular basis for the condition and as to the advisability of antispasmodic treatment.

Fig. 8.—Left fundus of a patient (not included in this series) with acute central angiospastic retinopathy. A marked circular reflex and edema of the macula are shown.

## COMMENT

From the ophthalmologic and general findings in our own cases we feel no doubt as to the circulatory origin of the conditions observed. The transient nature of the attacks, with complete or almost complete recovery of function, the frequency of recurrences, the opththalmoscopic evidence of edema during the acute attacks with slight atrophic changes afterward, the predominant involvement of the macular area with its peculiarly vulnerable blood supply and the absence of congestion, precipitates or opacities of the vitreous, common to all our cases, suggest a circulatory disturbance rather than any form of inflammation. The special examinations described afforded, in all but 1 case in which examination was done during the stage of activity, evidence of a high degree of arterial spasm. This evidence was objective and of a nature more definite than has hitherto been available in such cases. The improvement in these findings as well as in the ocular condition during antispasmodic treatment affords additional evidence in this direction. Aside from the objective findings, most of the patients had been aware

of having unusually cold hands and feet for years. There was no evidence of organic arterial disease in any case, and no pathologic reflexes or signs of nervous disease were found. The changes in the blood and the blood chemistry revealed nothing abnormal, and urinalysis gave negative results in all cases. None of our patients showed evidence of syphilis or tuberculosis, and when focal infection was present it seemed doubtful if it should be considered as anything but a contributing factor. One may imagine that a shower of toxic material thrown into the blood stream might produce angiospasm in this vulnerable region in a person with an especially labile vasomotor system.

These findings simply confirm the opinion of Horniker with regard to his group of cases. His name, central angiospastic retinitis, although the most descriptive one yet applied to the condition, would certainly be improved by substituting the term retinopathy, descriptive of a pathologic condition without the implication of an inflammatory origin. Included in this group would be the cases of central capillaritis described by Bailliart, Héry and Cattaneo and the retinitis centralis annularis of Kraupa. It seems likely that a number of conditions described by various other names were really of identical nature. These include the acute primary macular disease of Batten, the central retinitis and central serous retinitis of the Japanese, the preretinal edema of Guist and the idiopathic flat detachment of the macula described by Walsh and Sloan.

Although similar changes in the central artery have been seen by us in persons with general hypertension and arteriosclerosis, it seems undesirable to include such conditions in this special group. We prefer to emphasize the occurrence of this picture in young or middle-aged persons without signs of organic vascular disease. It will be noted that all of our patients were men and that a definite predominance of males was noted in the series of other observers. Just what significance this incidence may have is not clear, although smoking must be considered as a possible factor in producing angiospasm.

It must be emphasized that ophthalmoscopic findings are minimal in the early stages of the condition. They may easily be overlooked by ordinary ophthalmoscopic examination, when the diagnosis of retrobulbar neuritis is likely to be made. Careful examination of the macular region with the fine beam of the Friedenwald ophthalmoscope, with the Gullstrand ophthalmoscope or by means of red-free light will reveal signs of retinal edema which will localize the condition in the retina.

Treatment in these cases was directed toward securing vasodilation through relief of angiospasm. Instructions as to hygiene and habits should be given carefully. Tobacco should be forbidden to patients suffering from angiospasm. Exposure to cold should be avoided, and as much freedom from psychic trauma, worry and excitement should be secured as is possible. The nitrites are efficient as vasodilators, but

their action is transient and the untoward symptoms sometimes unpleasant. Typhoid vaccine administered intravenously, in addition to its nonspecific effect on inflammation, is an efficient vasodilator. Apparently vasodilation is secured by doses of 10,000,000 to 25,000,000 organisms, amounts much less than are usually employed to cause fever. Papaverine hydrochloride in doses of ¼ grain (16 mg.) administered intravenously is the most potent vasodilator available in our experience. It may be given three or four times a day if necessary, but in our cases it was seldom given oftener than once a day for short periods. As with other opiates, an overdose will depress the respiratory rate and other functions. An insulin-free pancreatic extract was used in several of our cases with apparent benefit. Twelve weekly injections of from 1 to 3 cc. subcutaneously are given, and the course is repeated after an interval of a month. Sedatives, particularly the barbiturates, will often suffice to relieve spasm in cases in which hyperemotionalism is a factor. One-fourth grain of barbital three times a day was given over fairly long periods in several of our cases without inconvenient symptoms. General metabolic disturbances should be corrected. When the metabolic rate is definitely low, circulatory efficiency is increased by enough thyroid extract to establish a normal rate. It was found to be —20 in 1 case. Some medication, and especially a rational regulation of hygiene and habits, must be continued for a considerable time in such cases, the need for treatment being determined by repeated examinations of the peripheral circulation.

## SUMMARY

A type of central retinopathy which affects young or middle-aged persons, especially men, with little or no increase in general blood pressure, is described, and illustrative cases are reported.

In our cases special examinations revealed definite signs of peripheral vascular spasm.

Reasons are given for believing that this and a group of similar conditions described under various names are due to spasm of the smaller retinal arterioles or capillaries, with resulting ischemia and edema of the retina, especially in its macular portion.

It is desired to emphasize the importance in such cases of special examination of the peripheral vascular system as a guide to diagnosis and treatment.

Various types of antispasmodic treatment, employed with apparent benefit in our group of cases, are described.

The name central angiospastic retinopathy seems the most useful one to describe the group of cases under discussion.

# CULTIVATION OF TRACHOMATOUS CONJUNCTIVAL EPITHELIUM IN VITRO

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With the Technical Assistance of Nancy Roberts

NEW YORK

The trachoma virus is not yet known with certainty to have been grown in tissue culture. The experiments of Rumyantsev and Levkoeva,[1] of Schmidt [2] and of Harrison and Julianelle [3] were unsuccessful. Poleff [4] reported finding in cultures of trachomatous tissues rickettsia-like bodies which he considered to be the causal agent, but he failed to demonstrate infectivity of the cultures by inoculation of the monkey or human conjunctiva. In view of the probable nonspecific nature of these rickettsia-like bodies, which I [5] believe to have been cellular débris, it seems probable that Poleff failed to cultivate the agent. More recently, Rötth,[6] in a report before the Fifteenth International Ophthalmologic Congress at Cairo, Egypt, stated that he had obtained Halberstädter-Prowazek inclusion bodies in a single culture of human fetal conjunctival epithelium inoculated with an Elford filtrate of trachomatous material. Before drawing conclusions as to the value of this single experiment, it

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From the Department of Ophthalmology, College of Physicians and Surgeons, Columbia University, and the Institute of Ophthalmology, Presbyterian Hospital.

1. Rumyantsev, A. V., and Levkoeva, E. F.: Growth of Trachoma Tissue in Vitro, Sovet. vestnik oftal. **1**:527, 1932; abstracted, Zentralbl. f. Ophth. **29**: 556, 1933.

2. Schmidt, R.: Züchtungsversuche der Einschlusskörper in die Gewebskultur, Klin. Monatsbl. f. Augenh. **91**:683, 1933.

3. Harrison, R. W., and Julianelle, L. A.: Studies on the Infectivity oi Trachoma: VI. Cultivability of the Infectious Agent in Tissue Cultures, Am. J. Ophth. **20**:360, 1937.

4. Poleff, L.: Culture des "rickettsias du trachome" in vitro, Arch. d'opht. **53**:882, 1936.

5. Thygeson, P.: Problem of Rickettsias in Trachoma, Arch. Ophth. **20**:16 (July) 1938.

6. Rötth, A.: Microbiologic Etiology of Trachoma, read before the 15th International Ophthalmological Congress, Cairo, Egypt, 1937; abstracted, Klin. Monatsbl. f. Augenh. **100**:115, 1938; abstracted, Rev. internat. du trachome **15**:31, 1938.

will be necessary to wait for reports of further trials and inoculation experiments. The observations of Busacca [7] and John and Hamburger,[8] published in 1938, likewise indicate failure to effect multiplication of the virus.

Although Pandit, Wright and Rao [9] obtained lesions transmissible in series following inoculation of unfiltered trachomatous material to the chorioallantoic membrane of the chick embryo, they were unable to infect the normal human conjunctiva with the affected membranes. In my experiments no evidence was obtained to indicate that the trachoma virus would multiply or survive either on the membrane of the developing egg or in minced tissues of the chick embryo under conditions giving good growth of vaccine virus. The results of Harrison and Julianelle [3] have also been negative. The trachoma virus would thus appear to be more fastidious than other viruses, the majority of which will develop well on chick embryo tissues. For this reason, human conjunctival tissues, particularly the epithelium, its natural host, may best be expected to provide a means for successful cultivation.

In preliminary experiments the technical requirements for successful cultivation of normal human conjunctival and corneal epithelium were examined and the results reported separately.[10]

## MATERIAL AND METHODS

For the present study, 48 specimens of tissue from trachomatous Apache Indian children from the Theodore Roosevelt Trachoma School at Fort Apache, Ariz., were utilized. The material was obtained through the cooperation of Dr. Polk Richards, medical director in charge of trachoma activities, and Dr. W. G. Forster, special physician of the Indian Service. In 4 cases the trachoma was of stage I; in 25 cases, of stage IIa and in 19 cases, of stage III (MacCallan's classification). Epithelial cell inclusion bodies occurred in 18 of the specimens, and in 7 they were present in large numbers. The infectivity of tissues prior to cultivation was demonstrated in 4 instances by the direct inoculation of baboons.

Epithelium was taken from the upper fornix after anesthesia with procaine hydrochloride (rarely with pontocaine hydrochloride). The excised tissues were washed gently in Tyrode solution, then cut into small squares with a cataract knife and placed in Carrel D3½ flasks, as described for the cultivation of normal con-

7. Busacca, A.: Observations sur la culture de tissus trachomateux par la méthode de Carrel et commentaires aux travaux parus sur ce sujet, Arch. d'opht. **2**:116, 1938.

8. John, I., and Hamburger, F. A.: Ergebnisse von Züchtungsversuchen des Trachom- und Paratrachomvirus, Arch. f. Ophth. **138**:760, 1938.

9. Pandit, G. G.; Wright, R. E., and Rao, S. R.: Preliminary Note on the Investigation of Trachoma by the Technique of Culture of the Chorioallantoic Membrane of the Embryo Chick, Indian J. M. Research **23**:475, 1935.

10. Thygeson, P.: Cultivation of Conjunctival and Corneal Epithelium in Vitro, Am. J. Ophth., to be published.

junctival epithelium. Of the three culture methods employed, the semisolid technic proved most satisfactory, but excellent growths were also obtained with the fluid and plasma clot technics. The medium consisted of 50 per cent human serum in Tyrode solution. Phenol red in a final concentration of 0.005 per cent was employed as an indicator in at least one flask of each series of cultures. Incubation was at 37 C. From three to six flask cultures were made from each of the tissues studied.

## RESULTS

Trachomatous conjunctival epithelium proliferated in vitro almost as readily as normal conjunctival tissues. Epithelium from persons with trachoma in the cicatricial stage appeared to develop more rapidly than that from persons with highly active trachoma. Of the 48 specimens of tissue cultured, satisfactory epithelial growths were obtained in 39

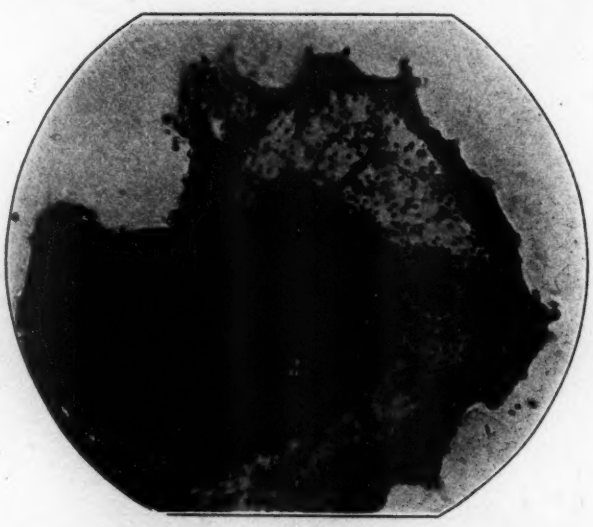

Fig. 1.—Forty-eight hour growth of epithelium from a patient with stage IIa trachoma (with inclusions). The dark central area is the original explant. The semifluid technic was used.

(figs. 1 to 4). As with normal tissues, the epithelial migration was preceded by wandering cells and followed after from twenty-four to forty-eight hours by a migration of fibroblasts. Although most cultures eventually became overrun with fibroblasts, fibroblast-free epithelium was obtained in a few instances.

In spite of the fact that a bacteriologic study had shown over half of the trachomatous subjects at Fort Apache to be secondarily infected, the tissue cultures were surprisingly free from bacteria; although infection of a single flask in a series was not uncommon, all the flasks in a series were infected in only one instance. This freedom from infection

may be attributed to the fact that conjunctival bacteria usually proliferate on the surface of the membranes but rarely penetrate the tissue itself.

### HISTOLOGIC APPEARANCE OF NEW GROWTHS

The new growths were indistinguishable histologically from those obtained from the normal conjunctiva. Epithelial cells, when examined under high magnification, appeared somewhat more granular than similar cells which had developed in vivo. No Halberstädter-Prowazek inclusion bodies could be demonstrated in any culture. In this connection it should be pointed out that no normal cell structures or artefacts which could be confused with the trachoma inclusions were observed in any of the cultures of trachomatous or normal epithelium. The well developed trachoma inclusion is perhaps the most distinctive of all virus inclusions, since its component granules, the elementary and initial bodies, have characteristic morphologic and tinctorial properties, and its matrix stains distinctively with iodine solutions.[11]

Fig. 2.—Fifty-six hour epithelial growth from a patient with stage I trachoma (with inclusions). The semifluid technic was used.

### INFECTIVITY OF CULTURES

There was no evidence to indicate either survival or multiplication of the trachoma virus in the cultures. New tissues grown from epithelium

11. Rice, C. E.: The Carbohydrate Matrix of the Epithelial-Cell Inclusion in Trachoma, Am. J. Ophth. **19**:1, 1936. Thygeson, P.: The Matrix of the Epithelial Cell Inclusion Body of Trachoma, Am. J. Path. **14**:455, 1938.

known to have been infectious from inoculation of baboons and known to have contained abundant inclusion bodies (experiments 7, 9, 11 and 17) did not develop inclusions and failed to induce disease when inoculated into baboons.

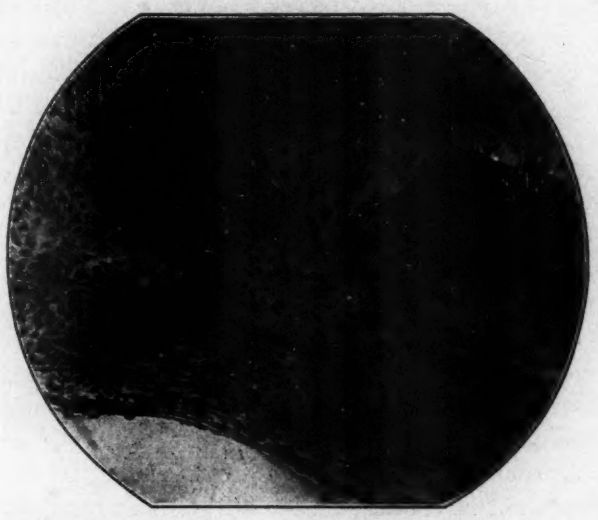

Fig. 3.—Seventy-two hour growth of epithelium from a patient with stage III trachoma (with inclusions). The semifluid technic was used.

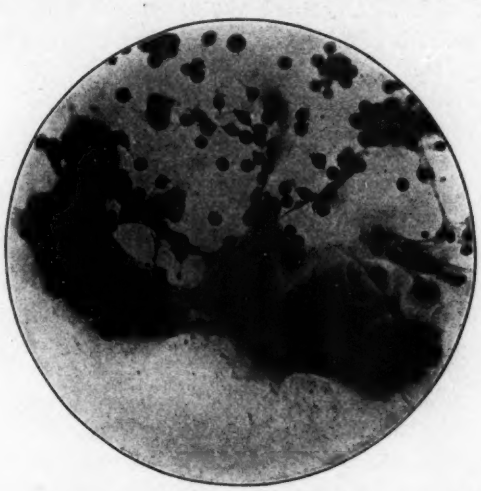

Fig. 4.—Part of a fifty-six hour growth of epithelium from a patient with stage IIa trachoma (with inclusions). The fluid technic was used.

## COMMENT

The extreme fastidiousness of the virus with respect to growth requirements is shown by its failure to survive under conditions which enabled its natural host, the conjunctival epithelial cell, to proliferate

abundantly. The problem thus resolved is to find and reproduce that special group of conditions, obtaining in vivo but so far not reproduced in vitro, which enables the virus to multiply. Environmental conditions which may be modified in tissue culture include: (1) $p_H$, (2) serum concentration, (3) tonicity, (4) oxygen and carbon dioxide tension, (5) viscosity of the medium, (6) inorganic salt concentration and (7) temperature. In view of the fact that the trachoma virus has certain properties characteristic of Rickettsia,[12] the recent observations of Zinsser, Wei and Fitzpatrick[13] and of Pinkerton and Hass[14] may prove to be of importance for the problem of trachoma. Zinsser and his co-workers found that in general viruses require for their multiplication cells having active metabolism, whereas rickettsias grow best in cells which have become stabilized and in which utilization of oxygen has almost ceased. Pinkerton and Hass found the temperature of incubation to be of primary importance in the multiplication of rickettsias. At 37.5 or 41 C., infected tissues were found to grow well but became rickettsia free and nonvirulent in a few days. At 32 C. the rickettsias multiplied and grew massively in nearly all cells in the culture. Other changes in environmental conditions, except those proving lethal for the cells themselves, produced but little effect on the intracellular multiplication of the organisms.

In view of the now extensive data available on tissue culture for both viruses and rickettsias, there seems to be every reason to suppose that the proper growth conditions for trachoma virus will ultimately be found.

## CONCLUSION

Conjunctival epithelium obtained from trachomatous Indian children with trachoma in all stages was grown in vitro. The histologic appearance of the developing tissues differed in no way from that observed in cultures of epithelium from the normal human conjunctiva. The trachoma virus failed to multiply and even to survive under conditions which enabled abundant growth of its normal host cells, evidence of its extreme fastidiousness in the matter of growth requirements.

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12. Thygeson, P., and Richards, P.: The Nature of the Filtrable Agent of Trachoma, Arch. Ophth. **20**:569 (Oct.) 1938.

13. Zinsser, H.; Wei, H., and Fitzpatrick, F.: Nouvelles méthodes de culture de Rickettsiae du typhus à propos de la production de vaccine, Compt. rend. Soc. de biol. **127**:229, 1938.

14. Pinkerton, H., and Hass, G. M.: The Study of the Pathogenic Rickettsiae in Tissue Culture, New England J. Med. **216**:466, 1937.

# PECULIARITIES OF WELL KNOWN OCULAR DISEASES IN THE NETHERLAND EAST INDIES

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I cannot expect American ophthalmologists to give much time to a consideration of ocular diseases in the Netherland East Indies. Conditions there are so different from those in the United States that it may seem that they are of little interest. Still, the problems in a territory as extensive as the East Indies might be worthy of attention.

In this tropical country live 61,000,000 persons, mostly natives; two thirds of them, or 41,000,000, live on the island of Java, which is densely populated. The number of patients with ocular diseases is very high and so is the number of the blind. According to the census of 1930, the Netherland East Indies had nearly 140,000 blind persons, that is, 244 per hundred thousand inhabitants. This number does not seem so high, as the incidence in the United States is 90 per hundred thousand inhabitants. However, as only those persons who could not perceive the movement of fingers close to their eyes were considered blind for the 1930 census, the total number of blind persons may be safely estimated, according to the Western definition, to be two or three times higher; hence one may accept that among every 100 natives more than 5 are blind. To cope with the ocular diseases which cause the blindness, there are 20 fully qualified ophthalmic surgeons and about 20 who are partially qualified; the general practitioners also do what they can to help these patients; their time and knowledge of diseases of the eye, however, are limited. One can see from this what an enormous amount of work there remains to be done in the Netherland East Indies to prevent and to treat blindness.

I shall divide the ocular diseases that are prevalent in the East Indies into two groups: those which are not known by most American ophthalmologists as they are not seen in the United States, and those that are well known. In this article I shall consider only the second group, as the well known diseases of the eyes often have an unusual character in the tropics.

Perhaps many think that cataract is one of the chief causes of blindness in the Netherland East Indies; the astronomic figures one sees when one reads about operations for cataract in British East India are

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the cause of this erroneous opinion. Cataract is probably no more frequent in the Netherland East Indies than in Europe. There are, however, a great number of persons with cataract who require operation, as in many parts of the archipelago ophthalmic surgeons are not available. The type of cataract seen in Java is quite distinct from that encountered in Europe. Most cataracts, even in young persons, begin as a central posterior subcapsular cortical cataract; later, a nuclear cataract develops. The perinuclear cortical cataract of the wheel-spoke type is extremely rare. In my opinion, the influence of infra-red rays may play some part in the cause of this type of cataract.

As to the chief cause of blindness in the East Indies, trachoma, I have not much to say. Its course and treatment are much the same as in other countries; the few improvements which have been made in the treatment are of small interest to American ophthalmologists as trachoma is not prevalent in their country.

Acute conjunctivitis, caused by the Koch-Weeks or the Morax-Axenfeld bacillus is of frequent occurrence. The first type especially occurs in epidemics; such epidemics are somewhat more frequent during the dry monsoon, but the differences in incidence are not great. The condition in many cases progresses to serious ulceration of the cornea and often to blindness. Hypovitaminosis A is often the cause of this ending.

Gonorrheal conjunctivitis is also often a cause of blindness. In many parts of the archipelago gonorrhea of venereal origin is prevalent, particularly in those sections close to the larger ports and European centers, for example, Java, Sumatra and Bali. In the more distant parts it is rarely seen. In my clinic I treat about from 100 to 150 adults with gonorrheal conjunctivitis yearly. The condition in most of these cases is distinctly of venereal origin; only rarely are patients seen who have no gonorrheal infection of the sexual organs, and these are usually children. Owing to the absence of any notion of hygiene, small epidemics of this disease sometimes arise; a number of months ago one of my assistants found 23 recent cases in one small village. I found one infected person to be the cause of a small epidemic in a home. Some Chinese children and their mother were suffering from acute conjunctivitis (probably of the Koch-Weeks type). The mother treated the children by washing the diseased eyes with freshly produced urine. As the mother was suffering from gonorrheal vulvovaginitis, the result is not surprising.

Many patients with gonorrheal conjunctivitis consult the doctor too late, when their condition is hopeless. When they are seen without an extensive corneal ulceration one can almost guarantee recovery with

good vision. I shall not give the details of the treatment used in the Netherland East Indies, but the principal measure is the intravenous injection of typhoid vaccine.

Gonorrheal iritis does not occur in the natives of the East Indies; in six years I have seen only 2 cases, 1 in a Chinese and 1 in a Eurasian.

It is remarkable that gonorrheal conjunctivitis is not frequent in the newborn and that in most cases it is benign.

Syphilis is seen as frequently in the same parts of the East Indies as is gonorrhea. I have seen many cases of ocular syphilis. During twenty years of practice in Amsterdam I saw 2 or 3 cases of gumma of the ciliary body; now I see as many cases a year. Syphilitic iritis in its different forms is very frequent. I see 1 or 2 cases every month. In striking contrast herewith is the rarity of keratitis parenchymatosa of heredosyphilitic origin. The explanation of this rarity is, perhaps, that the syphilis is so serious that the children die before or shortly after birth and thus keratitis parenchymatosa has no opportunity to develop.

Another most remarkable fact about syphilis in the Netherland East Indies is the rarity of cases of tabes dorsalis. Up to a few years ago tabes dorsalis was thought to be entirely absent among the natives. Now it is known that what was formerly diagnosed as idiopathic atrophy of the optic nerve is nearly always an early stage of tabes, as may be ascertained from the neurologic examination and especially from tests of the blood and spinal fluid. Almost every patient with tabes who was examined by my colleague of the neurologic department came to him from my department, as in 77 per cent of the cases the first complaint of the native with tabes is failing vision. Cases of ataxia with crises are rarely seen. It is interesting to look for an explanation of this fact. One may ask, thinking of the work of Lauber and Sobański, whether the low blood pressure of the natives may have something to do with it.

Pulmonary tuberculosis is frequent in the Netherland East Indies, so it is rather astonishing that tuberculous iridocyclitis and choroiditis are rare; I see only a few cases every year, and in those the disease is mostly rather benign. The only form of tuberculous disease of the eye I see often is sclerokeratitis. Why the sclerotic and the cornea of natives are easily attacked by tuberculosis and the uveal tract is so rarely attacked, I do not know!

A remarkable coincidence is that sympathetic ophthalmia, a disease which in so many respects resembles tuberculosis of the eye, is also rare in Java and is rather benign. Owing to the absence of skilled treatment of ocular injuries, one might expect to see many cases of this most disagreeable disease, yet they are rare.

Another disease which has points of resemblance to tuberculosis is leprosy. Leprosy is fairly abundant in the Netherland East Indies, yet

up till now I have seen only 1 case of leprous keratitis and uveitis. I often see patients with leprosy, but they come to the ophthalmologic department for another reason, viz., facial paralysis and hence lagophthalmos and often lagophthalmic keratitis.

Xerophthalmia is frequently seen, and it often progresses to keratomalacia and so leads to incurable blindness. It is even one of the principal causes of blindness in the Netherland East Indies. Knowledge of the peculiarities of this disease is rapidly increasing, but as I cannot deal with it in a few words, I shall not consider it here.

As to tumors of the eye, during my six years' stay in Batavia I did not see a single case of malignant melanoma of the uvea in a native, nor could I find a report of a case in the literature. In view of the facts that about 11,000,000 natives live in the western part of Java and about 300,000 Europeans and Eurasians live in the whole archipelago and that during this same six years I saw 2 cases of malignant melanoma of the uveal tract in Europeans, one can conclude that the disease must be much more rare in natives than in Europeans.

Anomalies of refraction are much less frequent in natives than in Europeans; probably for this reason concomitant strabismus is also rare.

Now that I have presented the most prominent differences in behavior and frequency between the ocular diseases of Europeans and those of the natives in the Netherland East Indies, my readers will want an explanation for all these differences. In some cases I have said already that I do not know. As to xerophthalmia, the insufficient food of the poor natives is the cause of the high frequency of this disease. In regard to most of the other diseases, the tendency is to suppose that racial, climatic and other circumstances are responsible for the differences; however, this is no more than a supposition without a solid foundation. Geographic ophthalmology is still a young branch of the old tree, but from many of the facts I have presented one can see that it promises to be an interesting science.

# MIXED TUMOR OF THE LACRIMAL GLAND

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Although a tumor of the lacrimal gland was first examined microscopically in 1867, the knowledge of the subject was chaotic until the report of Warthin [1] in 1901. In reviewing the literature at that time he found 132 cases of tumor of the lacrimal gland which had been reported under 44 different diagnoses. After carefully considering these reports, he concluded that practically all of these tumors could be classified as mixed tumors of endothelial origin, the confusion being due to their complex histologic structure. He was the first to suggest that tumors of the lacrimal gland are essentially the same tumor as are found in the salivary glands. Since his report, mixed tumor of the lacrimal gland has been generally accepted to be a definite clinical entity, similar pathologically to mixed tumor of the salivary glands.

Diseases of the lacrimal gland are so rare as to be clinical curiosities. The most common pathologic condition affecting the lacrimal gland is undoubtedly tumor. However, there are several inflammatory diseases of the gland. Acute dacryoadenitis is a well known, though rare, entity, usually caused by mumps but often caused by the Koch-Weeks bacillus.[2] Tuberculous dacryoadenitis [3] and fungus infection of the gland [4] have been reported. Bilateral symmetric enlargement of the lacrimal and salivary glands has long been known as Mikulicz' disease.[5] This probably is merely a symptom complex caused by chronic inflammatory infiltration of the gland by such processes as leukemia, tuberculosis and syphilis, although in some instances the condition may be a true clinical

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1. Warthin, A. S.: Endothelioma of the Lacrimal Gland, Arch. Ophth. **30**: 601-620, 1901.

2. Fralick, F. B.: Acute Dacryoadenitis, Am. J. Ophth. **18**:19-20, 1935. Rogol, B.: Acute Dacryoadenitis, Lancet **1**:982, 1937. Wright, R. E., and Nayer, K. K.: Acute Dacryoadenitis, Brit. J. Ophth. **21**:367-368, 1937.

3. Motto, M. P., and Rowen, E. H.: Tuberculous Dacryoadenitis, Am. J. Ophth. **12**:818-821, 1929.

4. Christopherson, J. B., and Archibald, R. G.: Primary Nocardiasis of the Lacrimal Gland, Lancet **2**:847, 1918.

5. Mikulicz, J.: Berl. klin. Wchnschr. **25**:759, 1888.

entity.[6] Atrophy of the lacrimal gland in association with xerophthalmia from vitamin A deficiency has been thought to be a factor in the production of the ocular symptoms.[7] Dislocations [8] and cysts of the lacrimal gland or dacryops [9] have been described as clinical entities.

Even though it is the commonest of diseases of the lacrimal gland, with the possible exception of Mikulicz disease, mixed tumor is relatively rare, Neely [10] in 1937 finding only 267 reported cases. Approximately 90 per cent of all tumors of the lacrimal gland are mixed tumors. Cases of fibroma [11] and hemangioma [12] have been reported, but the growths in the greater part of the remaining cases are lymphoma,[13] sarcoma and carcinoma. According to Colley [14] there are only 2 cases of fibrosarcoma reported in the literature. Round cell sarcoma is probably slightly more common.[15] The relationship of sarcoma to the mixed tumors will be discussed later, as will that of adenocarcinoma.[16]

In the literature on mixed tumor of the lacrimal gland there are only a few articles in which more than a single case is reported, owing of course, to the relative infrequency of the condition. The largest

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6. (*a*) Lane, L. A.: Tumors of the Lacrimal Gland, Am. J. Ophth. **5**:425-434, 1922. (*b*) Griffith, J. P. C.: Mikulicz's Disease and Mikulicz's Syndrome, Am. J. M. Sc. **178**:853-860, 1929.

7. Collins, E. T.: The Harderian Gland, Tr. Ophth. Soc. U. Kingdom **50**: 201-230, 1930.

8. Smith, J. W.: Spontaneous Dislocations of the Lacrimal Glands, Tr. Sect. Ophth., A. M. A., 1933, pp. 43-57.

9. Landman, O.: Dacryops, Arch. Ophth. **54**:592-597, 1925.

10. Neely, J. M.: Mixed Tumor of the Lacrimal Gland, Am. J. Path. **13**: 99-107, 1937.

11. Klempter, L. H.: Fibroma of the Lacrimal Gland, Northwest Med. **26**: 212-213, 1927.

12. Patry: Angiome caverneux de la glande lacrymale, Schweiz. med. Wchnschr. **59**:561, 1929.

13. (*a*) Pfingst, A. O.: Neoplasms of the Lacrimal Gland, Arch. Ophth. **55**:139-151, 1926. (*b*) Wells, A. P. L., and Mayou, M. S.: Lymphoma of the Lacrimal Gland, Tr. Ophth. Soc. U. Kingdom **30**:97-101, 1910. (*c*) Francis, L. M.: Malignant Lymphoma of the Lacrimal Gland, Am. J. Ophth. **6**:182-183, 1923.

14. Colley, T.: Tumors of the Lacrimal Gland, Brit. J. Ophth. **15**:305-314, 1931.

15. (*a*) Alger, E. M.: Sarcoma of the Lacrimal Gland, Arch. Ophth. **48**: 372, 1919. (*b*) Greeves, R. A.: New Growths of the Lacrimal Gland, Roy. London Ophth. Hosp. Rep. **19**:237-263, 1914.

16. (*a*) Freyberg, R. H.: Adenocarcinoma of the Lacrimal Gland, Am. J. Ophth. **15**:417-422, 1932. (*b*) Francis, L. M.: Adenocarcinoma Probably Arising from the Lacrimal Gland, ibid. **7**:260-262, 1924. (*c*) Davies, W. S.: Neoplasms of the Lacrimal Gland, with Report of Two Cases, Arch. Ophth. **12**:33-37 (July) 1934.

Fig. 1.—Typical appearance of patients (*A*, case 1; *B*, case 7) showing exophthalmos and displacement of the globe.

Fig. 2 (case 4).—Extreme exophthalmos of 18 mm.

Fig. 3 (case 8).—*A*, patient before removal; *B*, patient one year later, with a recurrence.

series in the literature, consisting of 7 cases, is that of di Marzio,[17] reported in the Italian literature in 1937. There are two series of 5 cases each, that of Verhoeff[18] reported in 1904, and that of Benedict and Broders,[19] reported in 1930. Three cases were recorded by Greeves[16b] in 1914 and 2 each by Pfingst[13a] (1926) and Davies[16c] (1934). As most of the instances of mixed tumor have been reported as single cases, there seems to have been little attempt made to follow the patient for more than a few months after removal of the growth. The lack of a large series of adequately followed patients makes it difficult to obtain a comprehensive idea as to the clinical course and final outcome in such cases.

In the present report the records of 12 proved cases of mixed tumor of the lacrimal gland are available for study.[20] Ten of the patients have been followed for more than two years. The clinical course in the cases making up this relatively large series has proved to be so consistent, as followed over a number of years, that some valuable conclusions as to the clinical and pathologic nature can be drawn.

## SYMPTOMATOLOGY

The presenting symptoms in the 12 cases analyzed here were essentially those of a slowly growing orbital tumor. As might be expected, the most striking symptom was exophthalmos, which was present in all cases. With few exceptions this was the first noted symptom and the one for which the patient sought medical advice. In several instances this was first noted by persons other than the patient. The amount was usually from 5 to 7 mm. but in case 4 it was as high as 18 mm. Accompanying the proptosis, there was usually some displacement of the globe downward and occasionally outward. As the exophthalmos progressed, it was often complicated by marked brawny edema of the lids.

Probably the most consistent diagnostic finding was the presence of a palpable mass in the region of the lacrimal gland, under the outer half

17. di Marzio, Q.: Tumori dell'orbita: Cilindroma della ghiandola lacrimale, Riv. oto-neuro-oftal. **14**:65-108, 1937.

18. Verhoeff, F. H.: The Mixed Tumors of the Lacrimal and Salivary Glands, J. M. Research **8**:319-340, 1904.

19. Benedict, W. L., and Broders, A. C.: Adenocarcinoma of the Lacrimal Gland, the So-Called Mixed Tumor, Am. J. Ophth. **13**:585-595, 1930.

20. Four of these cases are from the Institute of Ophthalmology of the Presbyterian Hospital, New York, the individual cases being reported with the permission of Drs. John M. Wheeler (case 3), D. B. Kirby (case 6), A. B. Reese (case 8) and L. C. Moss, Washington, D. C. (case 9). Case 10, from the Missouri Pacific Hospital, St. Louis, is reported with the permission of Dr. O. B. Zeilert. Case 11 is from the Barnard Free Skin and Cancer Hospital and the City Hospital, St. Louis. The remaining 6 cases are from the Barnes Hospital, St. Louis. Case 5 is reported with permission of Dr. V. P. Blair and cases 2 and 12 with permission of Dr. J. B. Brown, these cases being from the plastic surgery service.

of the superior orbital brim. This was usually felt as a small, hard, sometimes nodular, mass, but in several instances it was described as soft. In case 9 the mass was felt through the lower lid just above the inferior orbital margin. This may have been due to the occurrence of the tumor in an abberant gland or to the prolapse of a portion of the gland below the external canthal ligament. In only 1 case (5) was no

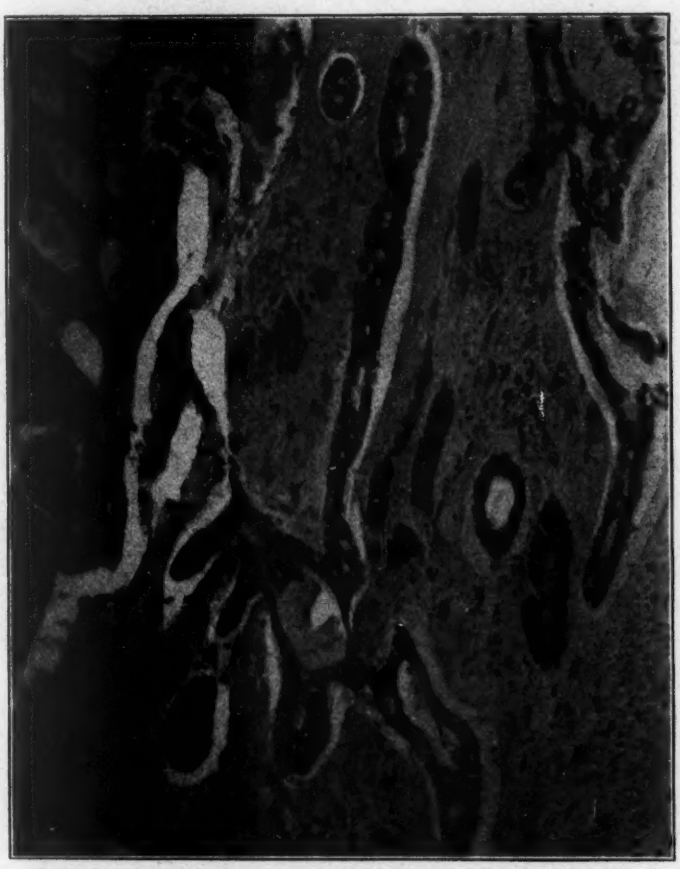

Fig. 4 (case 9).—Typical microscopic appearance of the tumor showing variations in arrangement of tissues.

mass palpable, the tumor being so malignant that nasal obstruction was noted from invasion before the mass developed.

The earliest ocular complaint was transient, indefinite diplopia. As the mass increased in size this was accompanied by a limitation of movement, usually superiorally and temporally. This was probably due to the globe impinging on the tumor mass plus some actual weakness of the superior and lateral rectus muscles. In 6 cases there was marked

loss of vision below 3/60 when the patients were first seen, and 2 patients had moderate loss of vision. The vision of 6 was normal, but in these cases there was usually subsequent loss as the condition progressed.

The fundus was normal in 5 cases and was not visualized in 2. In 3 cases there was blurring of the disk, the elevation in 1 being as much as 2 diopters, and in 2 there was pallor of the disk. Pigmented scars were present in the posterior pole in 2 cases, in 1 associated with a blurred disk and in the other associated with pallor. Peculiar pigmented striations of the fundus, proved histologically to be folds in the retinal pigment layer, were noted in case 1. This condition has been noted previously,[21] removal of the pressure from the tumor resulting in its disappearance.

In the majority of cases the onset was very insidious, with a slow but steady progression of symptoms. As stated, usually the first symptom is exophthalmos, but lacrimation, diplopia, loss of vision and nasal obstruction have been the original complaint. In the majority of the reported cases this had usually been present for from one to three years when the patient was first seen. In 4 of the cases in the present series, the duration of symptoms had been under one year; in 7, between one and three years, and in 1, approximately twenty-five years. It is often stated that in such cases a slight amount of exophthalmos is present over long periods, with a sudden increase in amount. This was true only in the case in which the duration of the exophthalmos was twenty-five years. This extremely long duration is rare, but has been reported.[22]

The patients complained of surprisingly little pain or discomfort. Several had an occasional dull ache in the orbit. The general health of practically all the patients was good.

All 12 of the patients were white, 7 being males and 5 females. The left gland was affected seven times and the right five times. There were no cases of bilateral involvement, a condition which has never been reported. The majority of the patients were middle-aged, 6 being in their fifties and 3 in the forties. Only 1 patient was over 60. The two remaining patients were 26 and 13 years of age. The average age of these patients is 47.3 years, the average age in the 95 cases reported by Lane being 39.2 years. Curiously, the oldest and the youngest patient obtained the best clinical result.

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21. Last, M. A.: Mixed Tumor of the Orbit of the Salivary Gland Type: Successful Removal, with Preservation of the Eyeball, Arch. Ophth. **13**:812-818 (May) 1935. Ziporkes, J.: A Case of Mixed Tumor of the Lacrimal Gland with Retinal Folds and Choroidal Detachment, Which Disappeared After Removal of the Growth, ibid. **18**:933-937 (Dec.) 1937.

22. Gipner, J. F.: Mixed Tumor of the Lacrimal Gland, Tr. Am. Ophth. Soc. **29**:392-395, 1931.

## CLINICAL COURSE

The study of the clinical course in these cases over a period of years has proved to be the most interesting aspect of the series. As these cases were gradually collected it was surprising to find how remarkably similar and consistent the clinical course was, the original condition, the institution in which the patient was treated, the operating surgeon

Fig. 5 (case 7).—Typical microscopic appearance of the tumor showing variations in arrangement of tissues.

or the exact treatment seeming to make little difference. In observing the course I have been especially interested in local recurrence of the tumor, invasive growth, particularly in bone, and the final outcome.

Local removal of the tumor had originally been done in 8 of the 12 cases (1, 2, 3, 4, 6, 7, 8 and 9) and a more extensive removal in 3 (cases 5, 10 and 12). One patient (case 11) refused all surgical treatment.

In all of the 8 cases in the first group a well encapsulated, noninvasive tumor was apparently completely removed at the original operation. In

7 of these cases there was a local recurrence with a return of symptoms in an interval of from several months to two years, the average interval being fourteen and six tenths months. In case 7 alone there was no recurrence, the patient being free from evidence of tumor two years after removal (at the time of writing). In case 2 there were three local recurrences, the first deep in the orbit, the second in the lower lid and the third in the upper nasal quadrant of the orbit. At the time of writing, three years after the last removal, the patient was living without evidence of tumor but with osteomyelitis of the supraorbital brim, denuded bone and a draining sinus tract. Death occurred in cases 1, 4 and 6 from intracranial extension, each patient having had several local recurrences removed before exenteration of the orbit was done. The remaining 3 patients are living. Exenteration was done in case 8, but the tumor recurred in the bony wall of the orbit and cervical glands and spread diffusely in the skin of the cheek, neck and chest. A recurrent growth was removed in case 9 only a few months before this paper was written, the prognosis being poor as it was thought that the growth was not completely removed. In case 3 the recurrence was treated with roentgen rays, with an apparent arrest for four years and no evidence of invasive spread.

At the time of the original operation in cases 5, 10 and 12 such an invasive growth was found that a more extensive procedure was indicated. In case 10 primary exenteration of the orbit was done with curettage of tumor tissue that was found invading the ethmoid and frontal sinuses. Sixteen months after operation there was a recurrence of tumor tissue in the bone in the upper nasal quadrant of the orbit. The most invasive growth in the series occurred in case 5, nasal obstruction being the first symptom noted. The tumor could not be completely removed, being treated with radium, radon and roentgen rays. The patient died in one year from marked intracranial extension. A preliminary biopsy with implantation of radon seeds was done in case 12, but removal of the tumor with resection of the lateral bone wall of the orbit was necessary in six weeks. This was done so recently that the final outcome cannot be predicted. Surgical treatment was refused in only 1 case (11). The patient died in six years with a marked local invasive growth and intracranial extension. Autopsy showed metastases to the liver, lung and mediastinal lymph nodes.

In these cases there has been a consistent tendency for early and extensive invasion of the bony wall of the orbit. This has been noted, either by roentgen examination or by surgical exploration, in all the cases except 3 (2, 3 and 7), these being the cases in which favorable results were obtained. The growths in cases 5, 10 and 12 were the most invasive, bony invasion being present when the patients were first seen, before any surgical intervention had been performed. In the remaining

5 cases this invasive growth occurred following a recurrence, although in 1 case there were three recurrences without bony invasion. All 5 deaths were due to intracranial extension by an invasive growth in bone. In several cases the bony defect was found on operation after roentgen examination had given negative results.

Metastases occurred in 4 cases. In 1 of these the metastatic lesions occurred in both the preauricular and the cervical lymph nodes and in 1 case each in the preauricular, the cervical and the mediastinal nodes, respectively, tumor nodules being present also in the liver and lung in

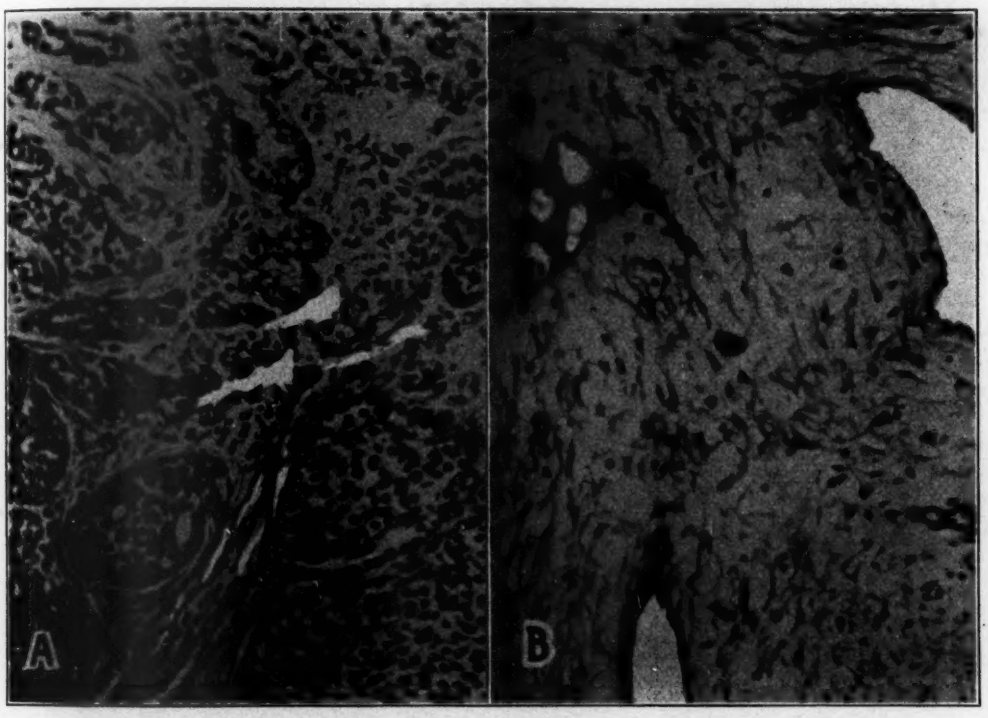


Fig. 6 (case 12).—Two areas in a single section of tumor showing extreme variation in relative amounts of epithelium and connective tissue.

the last case. As distant metastases were found in the only case in the series in which postmortem examination was performed, it is possible that they would have been found in the remaining fatal cases if autopsy had been done.

Thus of all 12 cases, a satisfactory result was obtained in 3, cure being effected in only 1 of these. One patient is free from tumor but has a serious complication consisting of osteomyelitis of the frontal bone. The growth in the third case is arrested after one recurrence following roentgen therapy. In the remaining 9 cases, or 75 per cent, there

was an invasive growth in the bony wall of the orbit. In 4 cases, or 33 per cent, there were metastases. There was a recurrence in 10, or 91 per cent, of the 11 cases in which treatment was surgical. Five, or 42 per cent, of the patients died from intracranial extension. However, this percentage is bound to be higher, as the condition of at least 2 of the patients is hopeless.

As these lacrimal tumors are supposed to be pathologically identical with mixed tumors of the salivary glands, a clinical similarity might be expected. The best figures available for these tumors are those of McFarland,[23] who has collected a series of 237 cases in which careful follow-up studies were made. He found a recurrence in 23.3 per cent, with 13 fatalities. In this series metastases occurred in only 4, or 1.3 per cent. The figures most often quoted for the lacrimal tumors are those reported in 1922 by Lane,[6a] i. e., recurrence, 20 per cent; death rate, 12.6 per cent, and metastasis, 7 per cent. Verhoeff [18] was able to follow 3 of 5 patients and reported recurrence in all. The present status of Benedict and Broders' cases [24] shows a recurrence in 3 of the 5 cases reported, with 2 deaths.

Recurrence of these tumors seems to be due to incomplete removal, as there is no evidence to suggest the presence of multiple tumors or the formation of a second tumor in a gland remnant. The high percentage of recurrence is due to two factors: the difficulty of surgical approach and the tendency toward bony invasion. In the region of the lacrimal gland wide dissection of the tumor is impossible, so that most of the encapsulated tumors were merely "shelled out," the recurrence probably being due to the tumor having invaded the capsule or to the mass splitting along a connective tissue trabecula, leaving a nodule of tumor. The location of the tumor in the lacrimal fossa in direct contact with bone would seem ideal for early bony invasion in any tumor with the slightest tendency in that direction.

The consensus concerning the clinical nature of mixed tumor, either of the lacrimal gland or of the salivary glands, as gathered from the literature is well expressed by a conclusion of McFarland: [23a] "Mixed tumors are inherently benign, but commonly recur after excision, and if frequently disturbed become locally destructive and invasive without giving metastasis." As relating to the lacrimal gland, frequent disturbance is not necessary for local invasion, as bony involvement occurred in 3 of these cases before operation and in 1 case in which operation was not performed there was not only marked local invasion but distant metastases. The high percentage of recurrence, the marked tendency

23. McFarland, J.: (*a*) Ninety Tumors of the Parotid Region, Am. J. M. Sc. **172**:804-848, 1926; (*b*) Three-Hundred Mixed Tumors of the Salivary Glands, Surg., Gynec. & Obst. **63**:457-468, 1936.

24. Benedict, W. L.: Personal communication to the author.

to local invasion and the metastasis as found in this series suggest that this tumor should be considered clinically malignant.

## PATHOLOGIC PICTURE

The histologic appearance of the tumors in this series was typical of that of mixed tumors of the lacrimal gland described in the literature and seemed to be microscopically indistinguishable from that of other mixed tumors of the oral-facial region, as found in the salivary glands, palate, nasopharynx, lips and skin of the face and scalp. Grossly, they

Fig. 7 (case 6).—*A*, section of a localized recurrence six years after removal of the original growth; *B*, section of an invasive recurrence seven months later.

are usually well encapsulated, with trabeculae extending throughout the tumor. They are histologically made up of epithelial and connective tissue elements, which not only vary in relative amount but in cellular differentiation and in arrangement of the various elements. This variation is evident not only in different specimens but throughout a single tumor or even in various areas of a section. Although this complexity is confusing from the standpoint of classification, it is so characteristic that these tumors are relatively easy to diagnose microscopically.

The epithelium may be arranged in well differentiated glandlike elements or in irregular masses. When in the form of anastomosing

cords, the tumor is often designated as a cylindroma, which is a morphologic variation of mixed tumor. The epithelial cells may become more spindle shaped, forming sheets and strands. These spindle cells in places seem to become squamous cells, as epithelial pearls are not uncommon. The mesenchymal elements vary from cartilage and adult fibrous connective tissue to the most immature myxomatous tissue, the more immature forms usually predominating. The relative amounts may vary from a tumor completely epithelial having the appearance of an adenoma or a carcinoma, to a myxomatous tumor with no apparent epithelial element.

Patey [25] stated that any recurrence of a tumor of the salivary glands takes one of two distinct forms: the encapsulated, in which the recurrence resembles clinically the original tumor, and the infiltrative, in which the tumor is locally invasive. This is in general true of tumors of the lacrimal gland in that encapsulated recurrences were present in 3 cases (2, 3 and 6) and infiltrative recurrences in 4 (1, 4, 8 and 9). The encapsulated recurrence is histologically similar to the original tumor, but in this series at least the infiltrative recurrences have shown a definite tendency to become more epithelial. In the most invasive tumors, particularly in bone, the connective tissue element is nearly completely outgrown, leaving the invading tissue almost entirely epithelial. This invasive element in some cases can be recognized as arising from the original tumor, while in others the solid epithelial mass resembles basal cell carcinoma to some degree. The metastases, both regional and distant, tend to be epithelial, although in some cases the mixed tumor appearance is retained. I do not believe that the microscopic appearance of the original tumor is of prognostic significance, although it may be significant that in this series the only 2 growths (cases 3 and 7) which included cartilage were noninvasive.

Early observers classified these tumors on the basis of their predominating tissues, this method of classification giving rise to innumerable descriptive diagnoses, such as adenoma, adenoid cystic epithelioma, myxochondrocarcinoma, adenosarcoma, etc. Their complex histologic structure led not only to a confusion of terminology but to a controversy as to their origin and nature, which is as yet unsettled. The theory that they are endotheliomas arising from the lymph spaces has been almost entirely abandoned. The most widely accepted theory at present is that these tumors are of purely epithelial origin.[26] Benedict

25. Patey, D. H.: Mixed Tumors of the Salivary Gland, Brit. J. Surg. **18**: 241-258, 1930.

26. (*a*) Martin, J. D., and Elkin, D. C.: Tumors of the Salivary Glands, Arch. Surg. **28**:727-741 (April) 1934. (*b*) Birch-Hirshfeld, A.: Zur Kenntnis der Mischtumoren der Tränendrüse, Arch. f. Ophth. **90**:110-128, 1915. (*c*) Li, P. L., and Yang, C. S.: An Inquiry into the Origin of Mixed Tumors of the Salivary Glands, with Reference to Their Embryonic Interrelationships, Am. J. Cancer **25**:259-272, 1935.

and Broders [19] thought that all these tumors were adenocarcinomas. The presence of the connective tissue elements has been considered to be due to a reaction to stimulation of the growing epithelial cells or to a formation from the epithelium by a process of metaplasia. Recently, Neely [10] presented evidence in favor of the theory which is also held by McFarland,[23a] that these tumors are truly mixed tumors of dual origin with both the epithelium and the connective tissue taking an active part in the growth of the tumor.

It was early suggested that these tumors were not actually of the gland but occurred in the region of the gland, arising from embryonic

Fig. 8 (case 6).—Invasive growth in bone showing the epithelial character of the tumor.

material isolated through defective development which would be particularly liable in the oral-facial region. Although this theory is most generally held at present,[27] these tumors may arise directly from the elements of the gland itself or from the accessory lacrimal glands of Krause.[19] In a recent paper on mixed tumor of the lung, Womack and Graham [28] suggested that these tumors arise from elements of the normal developing bronchial gland which do not reach complete maturity.

27. Neely.[10] McFarland.[23a] Li and Yang.[26c]

28. Womack, N. A., and Graham, E. A.: Mixed Tumors of the Lung: So-Called Bronchial or Pulmonary Adenoma, Arch. Path. **26**:165 (July) 1938.

*Clinical Findings and Course in Twelve Cases of Mixed Tumor of the Lacrimal Gland*

| Case No. | Sex; Age; Side | Initial Symptom; Duration | Exophthalmos; Duration and Amount | Mass | Displacement of Globe | Vision | Fundus | Diplopia; Limitation of Movement | Pain | Original Operation | Recurrence and Interval | Subsequent Treatment | Bony Involvement | Metastases | Final Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M 47 R | Lacrimation 1½ yr. | 1 yr. 5 mm. | Soft mass under superior orbital brim | Down and out | 2/60 | Papilledema, 2 D. | Occasional diplopia Limitation up and out | None | Through lid; well encapsulated tumor, easily shelled out | Small mass upper lid after 19 mo. | Cautery exenteration after first recurrence; second recurrence in 3 yr., treated with massive dose of roentgen rays; third recurrence in 6 mo.; dissection of neck for cervical adenopathy | Present after first recurrence | Cervical nodes | Death 6 yr. after first operation |
| 2 | M 13 R | Diplopia 6 mo. | Several weeks 5 mm. | Soft mass under temporal orbital brim | Down and out | Normal | Disk blurred; veins full | Indefinite diplopia Limitation upward | Headache for 3 wk. | Entire tumor including capsule removed | Recurrence in 2 yr.; tumor extending back toward apex | Recurrence removed locally; second rerence in lower lid in 1 yr.; third recurrence in superior nasal quadrant in 7 mo.; removed and radium applied; osteomyelitis with sinus tract | None | None | Living and well except for osteomyelitis 6 yr. after first operation |
| 3 | F 26 L | Exophthalmos 3 yr. | 3 yr. 5 mm. | Small nodular mass in upper temporal quadrant | None | Normal | Normal | Indefinite diplopia Motion intact | None | Through lid; tumor and capsule removed in one piece | Recurrence in 22 mo. | Recurrence found on exploration of orbit; no removal; treated with roentgen rays | None | None | Living with no evidence of tumor 6 yr. after original operation |
| 4 | F 58 R | Exophthalmos 25 yr. | 25 yr.; worse for last 2 18 mm. | Hard mass along lateral wall; inferiorly, mass is soft | Almost out of the orbit | 6/10 | Disk slightly pale; scar in nasal half | No diplopia Limitation in all directions | None | Removed through transconjunctival approach; densely adherent to bone | Recurrence in 15 mo. | Second removal incomplete because of bony invasion; 2 wk. later, cautery exenteration | Present at first operation; intracranial invasion | None | Died 3 wk.; after exenteration from meningitis due to invasion of tumor |
| 5 | M 51 L | Nasal obstruction 3 mo. | 3 wk. Not measured | No mass but slight bony defect in superior brim | None | Normal | Normal | Diplopia up and right Limitation up and right | Dull ache below left eye | At first operation, tumor found invading sinus; incomplete removal; radium therapy | Recurrence almost immediately | Radon implanted on two occasions without effect | Marked invasion of bones of face and skull | None | Died 1 yr. after original operation |
| 6 | F 42 L | Exophthalmos 2 yr. | 2 yr. 6 mm. | Firm mass projecting from beneath superior orbital brim | Downward | 3/60 | Not well visualized; radium cataract | No diplopia Motion intact | None | Local removal; details not known | Recurrence in a "few months" | Recurrence removed locally after 6 yr.; recurrence within 3 wk.; exenteration in 6 mo.; recurrence in bone, which was resected; resection of fifth nerve for pain, tumor in posterior fossa | Marked intracranial bony invasion | None | Died 9 yr. after first removal |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | M<br>63<br>L | Failure of vision<br>2 yr. | 1½ yr.<br>7 mm. | Soft mass in lacrimal fossa | Downward | 1/60 | Disk blurred; pigmented macular lesion | Diplopia at onset; no elevation<br>Limitation nasally | Occasional discomfort in orbit | Well encapsulated tumor shelled out through transconjunctival approach | No recurrence | No treatment except removal of cyst of conjunctiva | None | None | Well |
| 8 | M<br>54<br>L | Exophthalmos<br>2 yr. | 2 yr.<br>Not measured | Hard growth in superior temporal aspect of orbit | Downward | Normal | Normal | No diplopia<br>Weakness of lateral and superior rectus muscles | None | Removal locally; details not known | Recurrence in 8 mo. | No response to roentgen irradiation; exenteration of orbit; continued spread in bone, skin of neck, face and chest | Roentgen evidence of some invasion of bone noted before first operation | Cervical nodes | Living, with tumor invading bone and diffusing through skin |
| 9 | F<br>52<br>R | Exophthalmos<br>8 mo. | 8 mo.<br>Protrusion of lower lid | Hard movable mass palpable through lower lid above inferior brim | None | Normal | Normal | Indefinite<br>No limitation | None | Nonadherent tumor removed through lower lid | Recurrence in 17 mo. | Cystic recurrence invading antrum; removal | Invasion of antrum | None | Recurrence; probably incompletely removed |
| 10 | M<br>46<br>L | Exophthalmos<br>6 mo. | 6 mo.<br>Not measured | Hard nodular mass under upper temporal orbital brim | Down and out | Hand motion at 6 inches | Disk very pale | No diplopia<br>Limitation laterally | Pain for 1 wk. | Primary exenteration of orbit with curettage of ethmoid and frontal sinuses | Recurrence in bone of superior nasal quadrant in 16 mo. | Roentgen irradiation before and after recurrence; removal | Invasion of ethmoid and frontal sinuses; at operation; growth seems progressive | None | At present new invasion of bone |
| 11 | F<br>57<br>R | Lacrimation<br>3 yr. | 3 yr.<br>Not measured | Large mass in orbit extending into forehead, eroding bone | Downward | Blind | Not visualized | No diplopia<br>Eye fixed | None | No operation | ..... | Patient refused operation repeatedly; marked local invasive growth despite roentgen irradiation | Marked invasion of bones of skull | Liver, lung and mediastinal nodes | Died 6 yr. after onset |
| 12 | M<br>59<br>L | Exophthalmos<br>1½ yr. | 1½ yr.<br>Not measured | Hard firm mass outer aspect of orbit | None | 6/12 | Normal | No diplopia<br>Moderate limitation up and out | None | Biopsy and radon implantation | Continued growth of tumor | Removal of tumor with wide resection of bony wall of orbit | Bony involvement when patient was first seen | Preauricular lymph nodes | Operation too recent for prognosis |

In the invasive tumors, particularly those with metastases, the question of "malignant degeneration" always arises. As far as actual evidence is concerned either in the cases reported in the literature or in this series, "sarcomatous degeneration" of these tumors does not take place. If it ever occurs, "carcinomatous degeneration" of these tumors must be extremely rare, as is true adenocarcinoma of the lacrimal gland. Several of the authors [29] reporting cases of adenocarcinoma of the lacrimal gland stated that they believed that the growths arose from a mixed tumor. In 2 of the cases of this series (cases 1 and 10) the diagnosis was originally adenocarcinoma, but a mixed tumor was found in the local recurrence. When the entire original specimens were reexamined, mixed tumor tissue was found. Womack and Graham,[28] in studying a series of bronchoscopic biopsy specimens of early tumors of the lung, concluded that the original tumor in many cases of bronchogenic carcinoma was a mixed tumor.

If these tumors are believed to be purely epithelial, then not only the invasive tissue but the original tumor should be considered to be a type of carcinoma, as it is clinically malignant and does metastasize in some cases. Even though it appears that the epithelial tissue is the active element in these tumors, the mesenchymal element, although apparently passive, is probably also of a neoplastic nature. Therefore, I conclude, along with Neely [10] and McFarland,[23a] that this type of tumor is a true mixed tumor of dual origin and should be considered as an individual neoplastic entity. If this concept is accepted, then the epithelial invasion is not a "carcinomatous degeneration" but merely an infiltrative extension of a single element of this tumor which is characteristic of this particular type of neoplasm.

## TREATMENT

Judging from the final results in these cases, the present treatment, either operation or irradiation, is far from adequate. Nine of these patients have received some form of radiation therapy, either roentgen irradiation, radium or radon. With one exception the results have been uniformly poor, the irradiation seeming to have little effect on the tumor growth. Case 3 was the exception, there being apparent arrest of the condition for four years after a proved recurrence, which was not removed. This lack of response to radiation therapy is in accord with the findings in the literature. In several instances the metastases in the regional lymph nodes have seemed to respond favorably to irradiation. In none of these cases has the high voltage, fractionated method of Coutard, with a total dosage of from 12,000 to 15,000 roentgens, been

29. Freyberg.[16a] Davies.[16c]

attempted. This method might be particularly valuable as a postoperative procedure to prevent recurrence.

As irradiation is of little value, one must rely on surgical removal. In the present series this has been far from satisfactory and seems to indicate that a more radical procedure should be attempted. An essential preliminary to any type of operation is a careful roentgen examination of the walls of the orbit. If there is no evidence of invasive growth either roentgenographically or clinically, the tumor may be removed locally.

In the present series local removal was usually done by exposing the tumor, then "shelling it out." As suggested previously, this probably

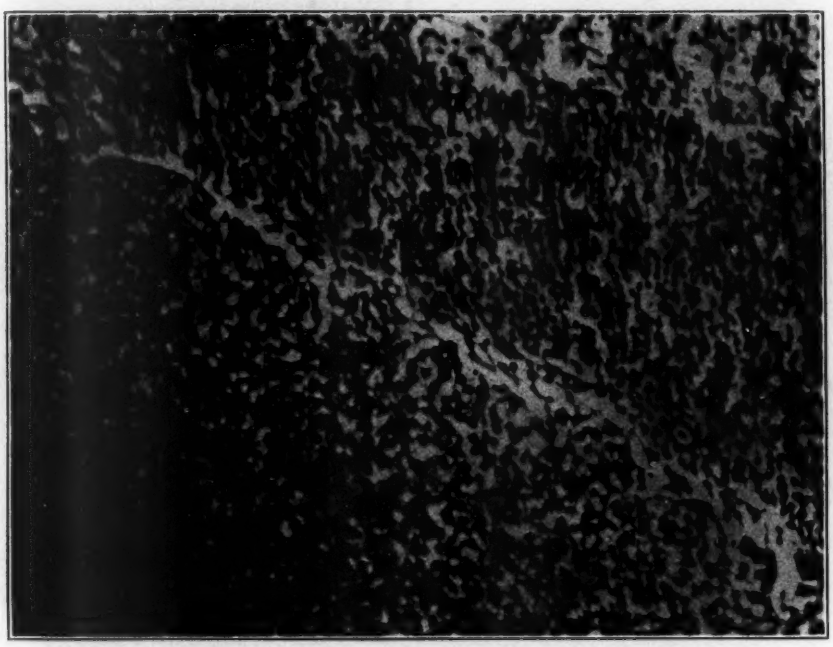

Fig. 9 (case 12).—Metastasis in a preauricular lymph node.

accounts for the large percentage of recurrences, in that by this method the tumor is incompletely removed in many instances. Although in the region of the lacrimal gland an extensive dissection is not possible, as wide a removal of the tumor, lacrimal gland and surrounding tissues as is possible should be attempted. Surgical attacks generally used have probably been too conservative, and a wider and more radical removal than a mere "shelling out" seems indicated.

Biopsy of these tumors is probably not indicated, as the information gained is not valuable enough to risk invasive growth following incision of the capsule. The invasion of the surrounding tissues after biopsy

seemed to have taken place in case 12. It has also been noted in the mixed tumors of the salivary glands by McFarland.[23b]

If there is invasive growth of the tumor either in bone or in the soft tissues of the orbit, complete removal of all the tumor-bearing tissue is essential. If bony invasion is thought to be present, either clinically or by roentgen examination, resection of the bony wall of the orbit is the only possible course. This was done in 2 cases in this series, the extension in case 6 being too great to perform complete resection and the postoperative interval in case 12 being too short for one to

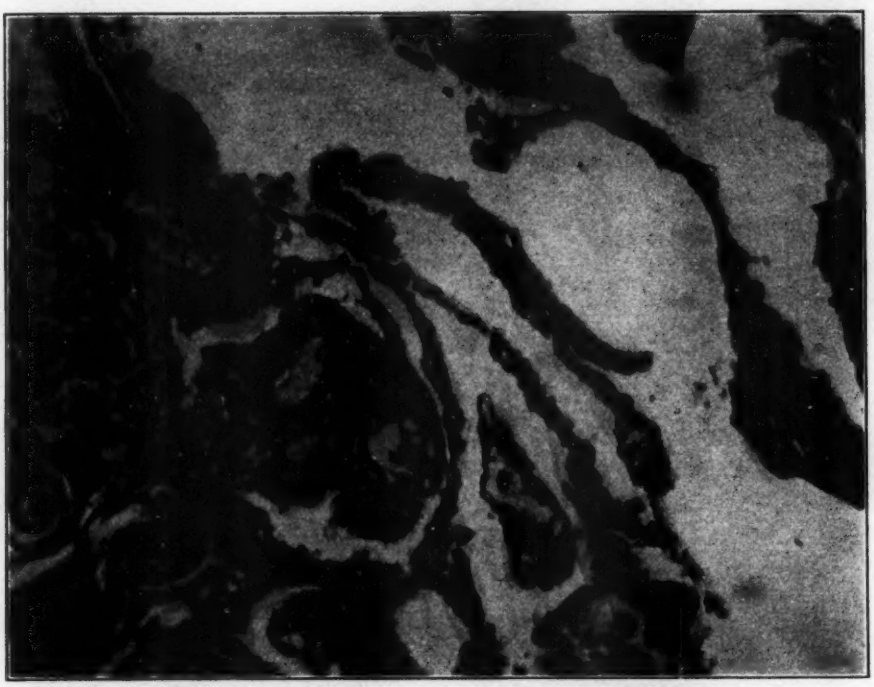

Fig. 10 (case 11).—Metastatic nodule in the lung.

foretell the result. If the tumor is found invading the soft tissues of the orbit alone, an immediate exenteration is indicated, as was done in 5 of the cases. This is usually unsatisfactory as it is delayed until bony invasion has taken place. Delay in these cases, as in the case of any malignant tumor, is usually costly.

Although the operative removal must vary with the individual growth, there are three surgical approaches available for the removal of these tumors. The usual method, used in 7 of these cases, is a direct approach through an incision in the outer half of the upper lid over the region of the lacrimal fossa. In 2 cases the transconjunctival approach

was used, in which a wide lateral canthotomy with division of the ligament is done. The incision is then extended into the lower and upper fornices of the conjunctiva, giving a wide exposure of the lateral half of the orbit. The Krönlein operation has been advocated by several authors.[30] The transconjunctival approach is probably superior to the direct approach in that the lacrimal fossa is adequately exposed and the remainder of the orbit can be much more easily explored and there is less resultant deformity and scarring. If the tumor is so extensive as to necessitate a Krönlein operation, then exenteration is probably indicated. However, a modification of this operation might be used to remove the wall of the orbit in those cases in which there is bony extension.

## SUMMARY AND CONCLUSIONS

A series of 12 cases of mixed tumor of the lacrimal gland is reported, 10 of the patients being followed at least two years. The symptoms are those of a slowly progressive orbital tumor and consist of exophthalmos, diplopia, limitation of motion, loss of vision and a palpable mass in the region of the lacrimal gland, which is a constant and an almost diagnostic finding.

Of 11 cases in which surgical treatment was employed, there was recurrence in 10, or 91 per cent. One patient refused operation and died in six years with marked local invasion and metastases to the liver, lung and mediastinum. Four, or 33 per cent, of the patients had metastases. Five, or 42 per cent, are dead from intracranial extension due to a marked tendency for bony invasion. Clinically, the growths in these cases should probably be considered malignant.

Histologically, the growths seem identical with mixed tumors of other locations, as described in the literature. The invasive element seems to be the epithelium. The recurrence is probably due to incomplete removal because of the difficulty of surgical approach and the tendency for early bony invasion. Pathologically, the mixed tumors are probably a definite pathologic entity of dual origin, with the characteristic tendency of the epithelial element to become locally invasive.

As irradiation is of little aid, early complete surgical removal is indicated. The local removal should be more radical than is usually done. If there is evidence of bony invasion, either roentgenographically or clinically, a resection of the entire tumor-bearing area is indicated, but if the invasive tumor is limited to the soft tissues, exenteration may be sufficient.

## ABSTRACT OF DISCUSSION

Dr. William L. Benedict, Rochester, Minn.: Since my report of 5 cases of mixed tumor of the orbit, made in 1930, I have operated in

30. Pfingst.[18a] Davies.[16c]

13 more cases. The patients were all white, the youngest being 20 years of age and the oldest 65. Seven were women and 6 were men. A tumor was found in the right orbit in 7 and in the left orbit in 6. Exophthalmos was an early sign in all cases and varied from 4 to 12 mm. In 7 cases exophthalmos had been noted for less than one year; in 3 cases, for only four months. In 6 cases exophthalmos had been noted for more than one year. In 1 case a nodule had been palpable at the upper temporal border of the orbit for thirty years but was noticeably increasing in size for only one year before operation.

The pathologic reports in this group revealed the following: adenocarcinoma, grade 1, 3 cases; adenocarcinoma, grade 2, 4 cases; adenocarcinoma and squamous cell carcinoma, grade 1, 1 case; adenocarcinoma, ungraded, 4 cases, and mixed cell tumor, 1 case. One patient had been observed since 1924, 1 since 1929, 1 since 1930, 2 since 1932, 4 since 1934, 1 since 1935, 2 since 1937 and 1 in 1938. All 5 patients observed for a period of five years or longer were known to be dead. The remaining 8 patients, all of whom have been under observation for less than five years, are still living. Two of these 8 patients are known to have recurrences. Recurrences have not been reported in the remaining 6.

Of the 18 cases of mixed tumor of the orbit arising in the region of the lacrimal gland, 5 reported in 1930 and 15 included in this report, in all but 2 operation was done through an incision in the brow. I have described this operation elsewhere. Two patients were operated on through a conjunctival approach combined with canthotomy. Radium or roentgen rays were used only in cases of extensive involvement in which complete exenteration of the tumor could not be carried out. I believe that mixed tumors and adenocarcinoma of the mixed tumor type cannot be treated adequately by irradiation. Early diagnosis and complete surgical removal are imperative.

DR. GEORGIANA DVORAK-THEOBALD, Oak Park, Ill.: Group studies of such cases as Dr. Sanders presents are of more value than individual case reports, as correlation of symptoms and histologic study of many cases give one greater knowledge concerning these curious tumors.

During the past twenty-five years at the Illinois Eye and Ear Infirmary 2 patients with tumors of the lacrimal gland presented themselves for treatment: a 15 year old boy with a mixed tumor and a 65 year old woman with Mikulicz disease in whom the gland was infiltrated with chronic granulomatous tissue.

The mixed tumors are often designated in the literature according to (1) their constituent tissue as fibroadenoma, chondrosarcoma, chondroepithelioma and adenoma; according to (2) the disposition of their tissues as cylindroma; according to (3) their histogenesis as endothelioma, or according to (4) their clinical evolution. Hence, confusion reigns, owing as much to this nomenclature as to their clinical differences and the great variety of their structural tissues. The term "mixed tumor" is applied to the great majority of these formations of the lacrimal gland; their structure indicates a complex building up of fibrous and mucoid tissue, hyaline cartilage and glandular tubes with cellular masses of disseminated epithelium. Differential stains show that there is a sharp differentiation between the epithelial elements and the fibro-

blastic stroma and that both of these tissues take an active part in the tumor growth.

These tumors are not strictly epithelial, and I think that Dr. Sanders rightly states that they should be accepted as a clinical and pathologic entity.

Dr. Howard C. Naffziger, San Francisco: My associates and I have operated on 5 of these tumors. The results have been depressing. The clinical diagnosis usually is not difficult, though we have had to differentiate certain meningiomas of the orbit, associated with which changes in the bone of the orbital roof occur. At other times the myopathies associated with thyroid disease, or the condition described in the English literature as exophthalmic ophthalmoplegia, have been confused with tumors of the lacrimal gland.

There was nothing distinctive in our 5 cases beyond the symptoms and findings in the clinical picture, as described by Dr. Sanders. The ages of the patients in this group were about the same, the youngest patient being 19 and the oldest 62.

A fact which impressed me in Dr. Sanders' paper, and also in the literature, is the extreme hopelessness of the condition. It is not quite clear to me in Dr. Sanders' paper whether the 1 patient reported as well had remained well for two years or whether it was for a longer period. If it were not for that, the recurrences would be 100 per cent. It has been the experience of most physicians that these tumors recur.

The use of roentgen rays and radium has not been satisfactory in our hands, and we have been endeavoring more and more to reach some method of surgical approach by which a sufficiently radical procedure could be done to permit a cure. This, of course, implies treatment before there is an extension locally and to the sinuses. The operative exposure that we have used permits a more thorough extirpation of an orbital mass than any other method with which we are familiar. Through a frontal flap, as in the operation for malignant exophthalmos, the entire roof of the orbit is removed as far as the frontal sinus anteriorly and to the ethmoid sinuses mesially. At the posterolateral portion of the orbit beneath the anterior part of the temporal muscle the removal of bone is carried up to the orbital rim and backward to the orbital fissure. Such a wide exposure permits the best opportunity for radical treatment.

The results of surgical treatment of tumors of the lacrimal gland, to date, are such that an earlier and more thorough surgical attack cannot be urged too strongly.

Dr. Thedore E. Sanders, St. Louis: If Dr. Benedict thinks that these tumors are purely epithelial, he is quite right in regarding them as carcinoma. I believe that they are of dual origin and should be considered mixed tumors. He grades these tumors as to malignancy. I have had no success at all in giving a prognosis from the histologic appearance of the growth. The wrinkling that he demonstrated was present in my series in 1 case in which the eye was removed, and on section it was found to be wrinkling in the pigmented epithelial layer of the retina.

The 1 patient who has had no recurrence has been followed only two years, and since the tumors in the literature have been known to recur as long as eighteen or twenty years after removal, I do not consider this man cured. If he should have a recurrence, the incidence of recurrence in my series would be 100 per cent.

I agree heartily with the procedure that Dr. Naffziger has outlined in those cases in which there is bony invasion. Unless all the tumor is removed, no matter how far the bone is invaded there is no hope; for this reason I think that a procedure such as this might be well worth while in certain cases.

# EVOLUTION OF A SUCKING DISK FOR INTRACAPSULAR EXTRACTION OF CATARACT

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NEW ORLEANS

Ophthalmic surgeons have vied with one another for years in developing a surgical procedure for removal of the cataractous lens in capsule. An operation employing a vacuum has met with some degree of approval.[1] It adopts a small cup-shaped protuberance on the distal end of a metal tube which is connected by rubber piping to an adjoining container from which the air has been exhausted. The atmospheric pressure, seeking to balance the vacuum, forces the lens into the cup and provides a grasp sufficiently strong for extraction of the lens from the eye.

The sucking type of instrument is frequently used for the intracapsular extraction of cataract; however, it is not used so often as forceps, yet has advantages over procedures employing forceps, for it will grasp successfully the lacerable as well as the nontearable capsule. The lacerable type of capsule can seldom resist tearing when a forceps is used. The limited popularity of the vacuum cup technic may be accounted for by the lack of an instrument to do justice to a principle and also by most of the paraphernalia. This contribution describes in detail a sucker which is simple and small. It can be as easily manipulated as a forceps, and the vacuum required is contained within a measure of a few minims. The instrument is neither cumbersome nor expensive.

This paper does not present the advantages of removal of the lens by intracapsular extraction but gives technical information regarding an erisiphake possessing desirable features; furthermore, this instrument can be used for another purpose, i. e., to suck intermittently on the capsule of the lens, thus rupturing the zonule. The latter attribute of the instrument may prove of great value and advance a principle for a future procedure.

The first satisfactory sucking cup instrument was that of Hulen.[2] He employed a 5 gallon (19 liters) demijohn for the vacuum; Down

1. G. C. Savage (in discussion on papers of McReynolds and Ewing, Tr. Sect. Ophth., A. M. A., 1922, p. 211) stated: "The Hulen operation, if an apparatus could be devised that was not clumsy, would be ideal." According to Frank Auten (in discussion on papers of McReynolds and Ewing, Tr. Sect. Ophth., A. M. A., 1922, p. 213), the Hulen method is ideal for getting the lens out of the eye.

2. Hulen, V. H.: Ophth. Rec. **19**:651 (Dec.) 1910; Vacuum Fixation of the Lens and Flap Suture in the Extraction of a Cataract in Its Capsule, Tr. Sect. Ophth., A. M. A., 1911, p. 122.

Brothers,[3] a 550 cc. bottle, and Barraquer,[4] a rubber tube 6 feet (182.8 cm.) in length with a 4 mm. bore. In 1933 I [5] described a metal syringe with a capacity of 10 cc. The instrument described here exhausts but a few minims of air. The rationale justifying the production of either large or continuous vacuum for the functioning of these instruments is not readily understood, since such instruments cannot accomplish a more secure grasp than one employing the measure of a few minims; moreover, they expose the eye to a hazard. When the cup loses contact with the lens, there is an inrush of air to balance the vacuum of the container. The demand of the large container is such as to force the lens to the bottom of the eye, whereas this does not occur when the vacuum produced is measured by the air contained in the cup and in the needle. It is possible that some thought that a greater grasp was to be obtained by removal of the air from a large container, either a demijohn or long rubber tubes. If so, they are mistaken. This newer instrument demonstrates that the vacuum essentially required to provoke a grasp in a sucking disk is that measured in the bore of the needle and the concavity of the cup.

Another feature of the older instrument, evidently a misconception, is the required depth of the sucking cup. Many seem to believe that the grip is greater proportionately to the concavity of the sucker; this belief is technically false, for the grip is dependent on the aperture of the grasper and not on the depth. The cup used in older instruments could have been almost flat and thereby would have eliminated the need to contend with the difficulty of inserting the cup into the incision; nor would it have occupied so much of the cubical space of the anterior chamber of the eye. These objections may have handicapped an otherwise excellent procedure. A discoid-shaped end such as is used in the new instrument is readily seen to possess many advantages.

### THE AUTHOR'S SIMPLE SUCKING TYPE INSTRUMENT

The instrument described here is an exactly ground glass syringe, the size of a fountain pen (fig. 1). It is without a valve, and the plunger does not travel upward more than one-sixth the length of the barrel. The movement upward of the plunger is effected by a coil spring and is limited by a metal cap at the top of the barrel. When an instrument is used that does not leak about the plunger, the ascent of the plunger need not be great to produce a vacuum of a density equal to that produced by the larger instruments. The instrument is inexpensive. It can be readily dissembled and the parts replaced, and the whole can be

3. Smith, J. R.: Brit. J. Ophth. **11**:152 (April) 1927.

4. Barraquer, I.: Clin. opht. **9**:167 (April) 1920; Am. J. Ophth. **3**:721 (Oct.) 1920.

5. Dimitry, T. J.: Vacuum Grasping Instrument for the Removal of Cataract in Capsule, Arch. Ophth. **9**:261 (Feb.) 1933.

sterilized by boiling. A 2 cc. glass syringe with a Luer-Lok attachment is employed. According to the manufacturers:[6] "The syringe has undergone a merciless series of tests, such as a hydraulic check under 70 lbs. pressure which unerringly detects a less than perfect fit between barrel and plunger." The hollow plunger of the glass syringe, originally 3 inches (7.6 cm.) in length, is cut to 1½ inches (3.8 cm.). To the bottom of this plunger is cemented one end of a steel rod the length of the original plunger. The rod runs through a cap which rests on the barrel. One end of a coil spring is fastened to the rod at the bottom of the plunger; the other end is fastened to the cap. When the rod is depressed, the glass plunger travels to the bottom of the barrel. If the nipple of the barrel is plugged and pressure on the rod released, there is no recoil, for the spring is not made sufficiently strong to overcome atmospheric pressure; when the plug is opened, the spring recoils, withdrawing the plunger, for the atmospheric pressure is balanced. When one is operating with the assembled instrument, the grasping cup having

Fig. 1.—The Dimitry sucking disk used for the intracapsular extraction of cataract. It is no larger than a fountain pen, and the plunger's maximum ascent is but one-sixth the length of the barrel. The essential ascent for a grasp is in keeping with the amount of air removed from the disk and the lumen of the needle.

been made to contact the lens, the plunger retracts only in proportion to the amount of air contained in the lumen of the needle and the concavity of the cup.

The adhering part of the instrument is flat. The edge of the discoid-shaped end is made sharp and is readily inserted into the corneal wound. It is made of thin sheet gold and is 4 mm. in diameter. The hollow needle has a small lumen and is made of platinum. When the grasper is inserted into the anterior chamber, distortion of the cornea is not produced, for the sucker, being flat, occupies little space. The details of the instrument are shown in figure 2; figure 3 shows how it is held in the hand when in use. The present instrument is held between the index and the middle finger while the hand is supinated, so that the

6. Becton, Dickinson & Co., Rutherford, N. J., specialists in glass syringes, 1938 circular.

thumb is free to control the plunger. It has also been found of advantage to adopt a position of grasp similar to that used by the Chinaman in holding his writing pi. The position of the plunger readily reveals when grasp is accomplished. Each surgeon has developed a special technic which he employs after the grasp has been accomplished.

Fig. 2.—The sucking disk instrument shown in detail. A spring is wound round a metal rod, which is cemented to the bottom of a glass plunger of a 2 cc. glass syringe. The plunger is five-sixths the length of the barrel. One end of the spring is fixed to the rod at the bottom of the plunger; the other end is fixed to a metal cap, which carries the rod in its travel. The sucking disk is of no greater thickness than the diameter of the needle.

Fig. 3.—Position of the fingers for holding the sucking disk. The position affords ready introduction of the disk into the wound. The thumb is free for controlling the plunger at will. Another method of grasp is like that used by the Chinaman when writing with his pi. The instrument has no valve.

I do not desire to digress from my subject; however, I would have it noted that neither the sucker nor a forceps is used to pull the lens from the eye. The lens is, in fact, pushed from the eye, the forceps or the grasper being used merely as a guide.

It has proved distinctly advantageous to have dispensed with a valve for controlling balance between the atmospheric pressure and that of the vacuum. The elimination of this feature, the ambition of so many hoping to devise an instrument which will not leak and at the same time can be easily manipulated, is equal in importance to the elimination of long rubber pipes, containers, electric motors, etc. The valve constantly presented a problem, and finally it was discovered to be unnecessary and a hindrance. The suction of the instrument is produced by a plunger, which is readily controlled and free from leaks up to 70 pounds (31.8 Kg.) of pressure. The instrument does not require the exhaustion of much air to accomplish the suction.

Claims have been made that vibration, as in the Barraquer instrument, is of inestimable value for rupturing the zonule. Whether or not this vibration is carried over to the lens is disputed, but if it is produced and is of value it can be readily seen that periodic grasp can be produced by the new instrument. Pressure with the thumb on the rod of the instrument will depress the plunger; on release of the thumb, the spring carries the plunger back, provoking thereby different degrees of tension in the capsule. The grip can be changed readily from one part of the capsule to another. Should the iris be caught in the cup, the thumb pressing on the plunger will release the grip.

## SUMMARY

To summarize, the evolved instrument has a sucking disk of 4 mm., which when applied to the lens adheres because of atmospheric pressure. The disk is an enlargement on the distal end of a hollow needle 1 inch (2.5 cm.) long which transmits the air pressure to an accurately ground and fitted glass syringe with a resisting power of 70 pounds of hydraulic pressure.

The syringe has a capacity of 2 cc.; however, the plunger is utilized to displace only the amount of air contained in the sucker and the lumen of the needle. This small apparatus accomplishes the same grasping effect as cumbersome instruments.

Vibration of the capsule can be produced merely by pressing and releasing the plunger of the instrument. There is no valve to contend with, and the apparatus is simple in every respect.

The evolution of this instrument may mean an increased popularity for the vacuum type procedure for the intracapsular extraction of cataract. Should such a procedure increase in popularity, this simple instrument is to play an important part. It presents additional evidence that progress comes through complexities to simplicity.

NOTE.—The grasping cup is no longer made of thin sheet gold but is fashioned of stainless steel, as is the hollow tube. V. Mueller & Co., who are now making the instrument, have helped to bring about this change.

# DISSOCIATED MONOCULAR NYSTAGMUS WITH PARESIS OF HORIZONTAL OCULAR MOVEMENTS

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AND
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The occurrence of the syndrome of monocular nystagmus and impairment of the horizontal conjugate gaze has been observed by Wilson,[1] Radovici and Savulesco [2] and Gaudissart.[3] Gaudissart reported a series of 11 cases and considered that the syndrome was common in cases of multiple sclerosis. A review of 150 consecutive cases of disseminated sclerosis from the neurologic service of the Mount Sinai Hospital showed an incidence of 2 per cent, i. e., 3 cases. The syndrome is characterized by two features: (1) impairment of lateral conjugate gaze, which is unequal in the two eyes, with paralysis of the adductor and paresis of the abductor;[4] and (2) monocular nystagmus in the abducted eye. This nystagmus is horizontal, slow and of large amplitude. For example, when the patient gazes to the right, the right eye is incompletely abducted and shows coarse nystagmus, while the left eye moves nasally, but not past the midposition (paralysis of the internal rectus muscle). When the patient gazes to the left, an analogous situation occurs. Occasionally a few fine nystagmoid movements are present in the adducted eye. Despite the weakness of the internal rectus muscles in conjugate gaze, good internal rotation on convergence was present in 1 of the 3 cases.

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From the laboratories and the neurologic service of the Mount Sinai Hospital, New York, and the Laboratory of Physiology of Yale University School of Medicine, New Haven.

1. Wilson, S. A. K.: Case of Disseminated Sclerosis with Weakness of Each Internal Rectus and Nystagmus on Lateral Deviation Limited to the Outer Eye, Brain **29**:298, 1906.

2. Radovici, A., and Savulesco, A.: Sur une variété de nystagmus dissocié, observé dans la sclérose en plaques, Rev. neurol. **1**:1010, 1927.

3. Gaudissart, P.: Paralysies des mouvements de latéralité des yeux et nystagmus dissocié dans la sclérose en plaques, Rev. d'oto-neuro-opht. **8**:684, 1930.

4. For the purposes of convenience and brevity, the terms adductor will be applied to the eye which adducts and abductor to the eye which abducts in horizontal conjugate gaze.

The nystagmus described herein is to be clearly differentiated from the spontaneous monocular movements observed in so-called latent nystagmus. Latent nystagmus is due to a congenital disturbance of the ability to fuse images. It can be elicited in certain subjects by interrupting normal binocular gaze either by closing one eye or by placing an object between the two eyes in a plane extended from the nose. It usually occurs in young children with defective ocular apparatus. Sorsby [5] reviewed the subject completely up to 1931. The following case reports are examples of monocular nystagmus due to disease of the nervous system.

## REPORT OF CASES

CASE 1.—*Blurring of vision and diplopia, with impairment of conjugate gaze, more marked in the adductor, and monocular nystagmus in the abductor; ocular divergence, impaired convergence and accommodation; ataxia in the extremities with pyramidal tract signs; appearance of paralysis of conjugate gaze to the right with disappearance of right monocular nystagmus; complete remission; diagnosis, multiple sclerosis.*

H. M., aged 34, was admitted to the Mount Sinai Hospital on March 30, 1938, with a history of blurring of vision for ten days and of diplopia for five days, before admission. The results of the general physical examination were not significant. The following neurologic signs were present: hyperactive deep reflexes, a positive Babinski sign on the right, ataxia and dysdiadokokinesia of the left upper extremity and slight weakness of the right facial nerve of the supranuclear type. There was an absence of abdominal reflexes. Examination of the eyes revealed bilateral incomplete ptosis; the left pupil was larger than the right, and both reacted well to light but poorly in accommodation; convergence was feeble. There was paresis of the conjugate gaze in either horizontal direction, but that to the right was more marked. When the patient gazed to the left, the left eye moved almost to the external canthus while the right was adducted toward but not past the midline. In this position, a coarse horizontal nystagmus of large amplitude was present in the abducted left eye but not in the right. When the patient looked to the right, an analogous reaction occurred, except that the right eye did not show as good power of abduction as the left, and the monocular nystagmus in the right eye was not conspicuous. The fundi were normal. The visual acuity was 10/20 in the left eye and 16/20 in the right. Caloric stimulation of each ear with cold water produced normal dizziness and past pointing. Stimulation of the left semicircular canals failed to produce symmetric nystagmus, nor did it increase the monocular nystagmus in the right eye. Stimulation of the right ear accentuated the monocular nystagmus in the left abducted eye and produced a slight jerky movement in the right eye. The slight nystagmoid movements in the right eye were only toward but not past the midline.

During the succeeding interval the patient became worse. The paresis of the conjugate gaze to the right developed into a paralysis, so that there was no dextroversion in either eye. With this, the monocular nystagmus in the right eye disappeared. Passive turning of the head to the left while the eyes were fixed on one point also failed to bring about lateral version to the right, showing that

5. Sorsby, A.: Latent Nystagmus, Brit. J. Ophth. **15**:1, 1931.

the paralysis of the conjugate gaze to the right was of a nuclear character. The patient was given thirteen injections of a foreign protein. He gradually improved. The paralysis of the conjugate gaze gradually receded. As the paralysis of the right lateral gaze changed to a paresis and the right eye was capable of abducting, monocular nystagmus reappeared in this eye. The diagnosis was multiple sclerosis. When the patient was discharged from the hospital, horizontal conjugate movements were almost normal.

CASE 2.—*Urinary disturbances, blurring of vision, ocular divergence and paresis of conjugate gaze, more marked in the adductor; dissociation of ocular movements with monocular nystagmus in the abductor and fine nystagmus of vertical gaze; good convergence; ataxia in the extremities with pyramidal tract signs; diagnosis, multiple sclerosis.*

H. V., a 35 year old insurance salesman, was admitted to the hospital on May 5, 1938. For four and one-half years before admission he had dragged his left leg, and for the past two years this weakness had progressed to the extent that he was unable to work. In addition, he had difficulty in starting the urinary stream. One year before admission he began to complain of blurred vision. Objects near him were clear, but at a moderate distance the eyesight was blurred. In order to clear his vision he had to close his left eye, but there was no diplopia. Neurologic examination revealed a broad-based, spastic gait, dysmetria and weakness of the left lower extremity, bilateral hyperreflexia and positive Babinski signs. There was slight ptosis bilaterally. The left pupil was slightly larger than the right, and both reacted well to light and in accommodation. The lid closure reflex was preserved. The power of convergence was good (fig. 1 *C*). There was paresis of the horizontal conjugate gaze, which was more marked when the patient looked to the right. When he gazed to the right both eyes moved past the central vertical plane to the right. The left eye (adductor), however, could not remain adducted and moved back to the midposition (dissociated ocular movement), while the right eye remained partially abducted and showed coarse monocular nystagmus. The monocular nystagmus was particularly evident when the patient made a strong effort to look to the side. Analogous conditions were noted, although not so marked, when he looked to the left. Caloric stimulation caused an increase in the amplitude of the monocular nystagmus in the abducted eye when either of the aural canals was irrigated. At rest, the eyeballs were in slightly divergent position. The red glass test did not reveal diplopia. On vertical gaze, upward more than downward, both eyes showed a fine, rapid nystagmus. The fundi and visual fields were normal. There were no scotomas. The visual acuity was 14/20 in the right eye and 16/20 in the left. The results of all the laboratory tests were negative. The clinical diagnosis was multiple sclerosis. The patient received a series of ten injections of a foreign protein, with but slight improvement. When he was discharged from the hospital there was no change in the ocular status.

CASE 3.—*Paresthesias, diplopia and weakness of the right lower extremity; poor convergence with paresis of lateroversion, more marked in adducted eye, and monocular nystagmus in the abducted eye; fine nystagmus on vertical gaze; pyramidal tract signs on the right; diagnosis, multiple sclerosis.*

W. R., a 44 year old man, entered the hospital because of weakness of the right leg. Ten years before admission he had an attack of scarlet fever. Soon thereafter he had diplopia of several weeks' duration. About this time sensations of pins and needles developed in the right thigh, which persisted intermittently for five years. Since then he has noted a progressive weakness in the right

lower extremity. Neurologic examination showed hyperactive deep reflexes, more marked on the right, with a positive Babinski sign on the right. The abdominal reflexes on the right were diminished; those on the left were normal. There was impaired vibration sense in the toes of both feet. The pupils were equal and reacted well to light but poorly in accommodation. The power of convergence was poor. Conjugate gaze was impaired to the right and left, each deviation terminating in nystagmus (monocular, coarse and horizontal), which was greatest in the eye which looked outward. During the act of ocular deviation, the adductor eye sometimes moved beyond the midline. The globes, however,

Fig. 1 (case 2).—*A*, paresis of the horizontal conjugate gaze to the left with greater weakness of the right internal rectus muscle; *B*, paresis of the horizontal conjugate gaze to the right with greater weakness of the left internal rectus muscle; *C*, excellent convergence despite paralysis of the interior rectus muscles on horizontal conjugate gaze.

could not be maintained in an adducted position and moved back to the mid-position, giving the picture of paralysis of the internal rectus muscle (dissociated ocular movements). The monocular nystagmus was more conspicuous when the patient made an effort to look to the extreme side. The left optic disk was pale; the right was normal. The visual acuity was 12/20 in the right eye and 6/20 in the left. The peripheral and central visual fields were normal. There were

no scotomas. Laboratory examinations, including Wassermann tests of the blood and spinal fluid, gave negative results. The patient was given injections of a foreign protein. There was no change in the ocular status. The diagnosis was multiple sclerosis.

COMMENT

In each of the 3 cases cited there was paresis of lateroversion with paralysis of the internal rectus muscle. Symmetric paresis of conjugate gaze due to pontile lesions is usually accompanied by nystagmus, which ordinarily is symmetric. When, however, there is a difference in degree of paralysis of either of the conjugate rotators (adductor or abductor), the nystagmus is unequal. In the less paretic eye (abductor), for instance, the nystagmus is conspicuous, whereas in the more paretic eye

Fig. 2 (case 3).—*A*, paresis of the conjugate gaze to the left with greater involvement of the right internal rectus muscle; *B*, paresis of the conjugate gaze to the right with greater involvement of the left internal rectus muscle.

(adductor) the nystagmus is barely visible. Obviously the impulses for movements in nystagmus do not reach the internal rectus muscles. When the paralysis of the conjugate gaze to one side is complete, as in case 1, no nystagmus is observed because impulses can reach neither the external nor the internal rectus muscles.

Recent studies of the corticonuclear pathway for horizontal ocular movements show that neural impulses pass from the cortex to the eyes through the vestibular nuclei (Scala and Spiegel [6]). The fibers from the cortex descend to the reticular substance of the pons. From there,

6. Spiegel, E. A., and Scala, N. P.: Cortical Innervation of Ocular Movements, Arch. Ophth. **16**:967 (Dec.) 1936.

they go to the vestibular nuclei. From the vestibular nuclei, impulses travel to the center for horizontal conjugate gaze and to the abducens nucleus. They then ascend in the posterior longitudinal bundle and cross to the nuclear center of the internal rectus muscle. Thus a lesion in the posterior longitudinal bundle lying between the levels of the abducens and oculomotor nuclei (internuclear ophthalmoplegia) would cause paralysis of the internal rectus muscles for conjugate action (Spiller[7]). The more caudal the lesion is in the bundle, the more likely are the centers for horizontal gaze to be affected in addition to the palsy of the medium rectus muscle. This is particularly evident when the lesion extends more to one side of the bundle, resulting in severe impairment of conjugate gaze on the side of the lesion.[8]

Experimental section of the posterior longitudinal bundles at the level of the facial colliculi in monkeys resulted in ocular disturbances which were almost identical with those observed in man. Such sections were made by Bender and Kennard[9] at Yale University. In every instance there was paralysis of the internal rectus muscles with ocular divergence and nystagmus in the paretic abductor. In one monkey the incision was made slightly to the left of the median raphe. This caused complete paralysis of conjugate gaze to the left and paralysis of the internal rectus muscles, and when the gaze was directed to the right, nystagmus in the right eye (abductor). (Compare with case 1.)

Horizontal ocular movements in these monkeys could not be induced either by caloric stimulation of the vestibular apparatus or by electrical stimulation of the cortical area of the eye. In some monkeys, as the impairment of the conjugate movement became less marked, caloric stimulation produced horizontal nystagmus, which was greater in the abductor and less in the adductor. (Compare with the clinical cases.)

Paralysis of the internal rectus muscles and nystagmoid movements by the action of the external rectus muscles were noted in experimental sections of the posterior longitudinal bundle in rabbits (Lorente de Nó[10]). The nystagmoid movements were also influenced by spontaneous action of the superior oblique muscle (vertical and rotation nystagmus). The impulses for the nystagmus arise in the substantia

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7. Spiller, W. G.: Ophthalmoplegia Internuclearis Anterior: A Case with Necropsy, Brain **47**:345, 1924.

8. The conjugate deviation of the eyes is carried out by impulses traveling in the bundle on the side to which the eyes deviate.

9. Bender, M. B., and Kennard, M. A.: The Fright Reaction After Section of the Facial, Trigeminal and Cervical Sympathetic Nerves, J. Neurophysiol. **1**: 431 (Sept.) 1938.

10. Lorente de Nó, R.: Untersuchungen über die Anatomie und die Physiologie des Ohrlabyrinthes und des Nervus octavus, Monatschr. f. Ohrenh. **61**:857, 1066, 1152 and 1300, 1927.

reticularis and vestibular nuclei. They are free from cortical impulses. In the monkey, nystagmus was found to be present on vertical gaze. There was a rotatory component to these movements. In man, fine vertical nystagmus was also noted.

The striking similarity in the syndrome observed in patients with multiple sclerosis and that produced experimentally in monkeys makes it possible for one to draw inferences as to the site of the lesion in the former. Despite the disseminated character of the pathologic process of multiple sclerosis, the syndrome of paralysis of internal rotation of one eye and paresis of external rotation in the other, with conspicuous nystagmus in the abducted eye, can be attributed to one lesion. This lesion is located in the posterior longitudinal bundle just at or above the abducens nucleus. Variations of the ocular disturbances cited may exist, depending on the extent, degree and level of the involvement of the posterior longitudinal bundle.

Dissociation between the actions of the internal rectus muscle, i. e., paralysis of the internal rectus muscle on conjugate gaze but not in convergence, such as was noted in the cases reported here, has been fully described by Spiller [11] (1924 and 1932). Experimentally, the more rostral and extensive the lesion, the more impairment of convergence. In the stage of recovery the disturbance in the convergence and divergence mechanisms in the monkeys was manifested by spasms of convergence and divergence, especially on vertical gaze.

SUMMARY

The case histories of 3 patients with paralysis of the internal rectus muscles and paresis of the external rectus muscles (paresis of conjugate gaze), with nystagmus only in the eye on the side to which the gaze was directed, are given. The same ocular disturbances were produced in monkeys by sectioning the posterior longitudinal bundle at the level of the facial colliculi.

11. Spiller, W. G.: Corticonuclear Tracts for Associated Ocular Movements, Arch. Neurol. & Psychiat. **28**:251 (Aug.) 1932.

# PATHOLOGIC PICTURE OF RETINAL DETACHMENT

## A SURVEY

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No other diseases of the eye have received more study in the last twenty years than glaucoma and detachment of the retina. Glaucoma was the subject of special attention in the decade following the World War, whereas during the last ten years detachment of the retina has come to the front. Notwithstanding the fact that Leber [1] reported the results of an extensive study of the etiologic factors and the pathologic picture of retinal detachment, anatomic investigations have been taken up again with renewed zeal.

Glaucoma and retinal detachment have many points in common as scientific problems.

1. In both diseases it is exceedingly rare to obtain recent or fresh preparations for anatomic examination.

2. It is not possible to produce these diseases in animals and to improve the knowledge by experiments. It is true that certain types of glaucoma and of detachment may be brought about by injections or operations, but the types are different from those commonly seen in human beings.

3. One of the reasons why an exact knowledge of the etiology and mechanism of these two diseases has lagged behind is that both embrace many different types, each type having a different cause, a different clinical course and a different ending. A classification of glaucoma into primary and secondary types had not been attempted during the lifetime of Albrecht von Graefe, who complained about the confusion in dealing with a multitude of different types.

### CLASSIFICATION OF RETINAL DETACHMENT

A classification of retinal detachment has not as yet been perfected. Detachments due to such causes as tumors, von Hippel's disease, Coats's

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Read before the Oxford Ophthalmological Congress, Oxford, England, July 9, 1938.

1. Leber, T.: Die Krankheiten der Netzhaut, in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 2, Leipzig, Wilhelm Engelmann, 1901-1911.

retinitis externa and retinitis proliferans are all undoubtedly secondary detachments. The precipitating cause is not situated in the retina itself.

That there is a difference in the etiology of retinal detachment has been long suggested in the German language. Whereas in the English language there is but one term, "detachment of the retina," in the German there are two terms, *Abhebung* and *Ablösung*. These two terms are alternatingly used in the same sense, although there is a slight etymologic difference. *Abhebung* is the direct German translation of ablatio. It means that the retina is pushed or pulled away, conveying the idea of an active removal, as by the action of a tumor of the choroid externally or by that of a membrane internally, as in retinitis proliferans. On the other hand, *Ablösung* conveys the idea of spontaneous separation or primary detachment, as if the retina by its own elasticity would take the form of a cord instead of an arc, the space between the retina and the choroid being filled with fluid ex vacuo.

This paper is confined to a consideration of cases of spontaneous detachment of the retina, with the exclusion of cases of detachment due to tumor and to all those conditions in which as the result of exudation or hemorrhage the separation of the retina from the choroid is secondary. In cases of spontaneous detachment there is a tendency, in the course of years, for two characteristic sequelae to develop. The first is iritis with secondary glaucoma, marked by intense inflammation and pain. The second is complicated cataract, which is as a rule conspicuous because the pupil is not narrow and is not covered by a membrane. The lens assumes a peculiar color. One may be urged in a case of this kind to undertake extraction for cosmetic purposes, which is always dangerous because the vitreous is fluid and may escape, and the detached retina may easily be injured in the operation if it becomes necessary to use a loupe. Especially interesting in the group of primary detachments are the cases in which transillumination throws a shadow and a differential diagnosis from necrotic tumor of the choroid presents itself. An extravasation of blood beneath the retina in the later stages may cast a shadow, which in connection with iritis and glaucoma may render it difficult to exclude a diagnosis of necrotic sarcoma, particularly if the patient is unable to tell how long the eye has been blind.

## PURPOSES OF PAPER

The chief purposes that prompted the undertaking of this paper, which is in the form of a survey of anatomic specimens, were first, to obtain information as to the etiology of lacerations, which has been the subject of wide interest in recent papers; second, to differentiate between recent and old changes in retinal detachment, which is of special importance as regards the posterior surface of the vitreous; third, to obtain

information as to degenerative changes in the retina, which are of greater interest now than they were formerly, because one may be requested to operate on a detachment of several years' duration, and fourth, to search for the causes of the development of iritis with glaucoma in cases of detachment of long standing.

## MATERIAL

The anatomic material employed was obtained from the collection of Prof. A. Fuchs, of Vienna, in which were included preparations from the collections of Prof. J. Meller, Prof. M. Salzmann, Dr. B. Klien, of Chicago, and the late Prof. E. Fuchs. All told, 41 cases were included in the study. Practically all of the globes had been enucleated because of the well known complications of iritis and glaucoma. There were 28 cases in this group in which a history was obtained with reference to the detachment. There was a history of myopia in 14 cases; of extraction of cataract in 1 case; of hydrophthalmos in 2 cases and of perforation of the cornea in 2 cases. In 9 cases there was a history of detachment only.

One had the impression that the number of detachments found in eyes with high myopia in this material, which included not only those with clinical evidence of myopia but also those in which it was indicated anatomically, was out of proportion to the number of myopic detachments seen in routine clinical material. In former years it was thought that high myopia is frequently the cause of detachment, but it is known from statistics based on operative evidence that highly myopic eyes are in the minority. Perhaps the former notion that myopia is the most frequent cause of detachment arose from the fact that myopic eyes are more inclined to complications and therefore are more frequently enucleated than others, so that the attention of oculists became more centered on them.

In the present anatomic material it is remarkable that none of the detachments was said to have come on after slight contusion of the eye, of the skull or of the body. If it is true that traumatic detachments of long standing do not so frequently lead to enucleation as do myopic detachments, the probable explanation is that the former are based on a natural constitutional friability of the retina, whereas in cases of myopia not only is a constitutional weakness of the retina present but in many instances real inflammatory changes are found in the choroid. At a certain age the vitreous of the myopic eye is practically always changed, as proved by the presence of large opacities and by the frequent occurrence of posterior detachment of the vitreous body. It is likely that the changes in the vitreous are not caused directly by the stretching of the sclera or by the length of the globe or wholly by degeneration due to

the advanced age, but that in addition to these causes certain toxins may play a role. In anatomic preparations lymphocytic infiltrations are found in various tissues of many highly myopic eyes, and moreover different kinds of tissue proliferation in such eyes are proof of an inflammatory influence.

In the 13 cases of the present series in which no history was obtained there was anatomic evidence of myopia in 4 and absence of such evidence in 9. The amount of myopia as given for the fellow eye varied as follows: —1.5, —12, —13, —14, —16, —18, —20 and —30.

TABLE 1.—*Age and Sex of Twenty-Eight Patients*

| Age, Yr. | Male | Female |
|---|---|---|
| 1-10 | 2 | .. |
| 11-20 | .. | 1 |
| 21-30 | 5 | 1 |
| 31-40 | 2 | 2 |
| 41-50 | 2 | 2 |
| 51-60 | 1 | 2 |
| 61-70 | 1 | 2 |
| 71-80 | 1 | 3 |
| 80 | .. | 1 |
| | 14 | 14 |

TABLE 2.—*Interval Between Discovery of Detachment and Enucleation*

| Interval | No. of Cases |
|---|---|
| 5 months | 1 |
| 1 year | 3 |
| 3 years | 2 |
| 4 years | 1 |
| 6 years | 1 |
| 9 years | 2 |
| 10 years | 1 |
| 12 years | 4 |
| 16 years | 1 |
| 18 years | 2 |
| 20 years | 3 |
| 25 years | 1 |
| "Many" years | 1 |
| Total | 14 |

In the 28 cases in which a history was obtained it was interesting to note that detachments occurred more often during the third decade than during any other decade. Clinically, detachments are mostly seen in persons of a more advanced age. Perhaps detachments that occur during the early years are more liable to give rise to complications that necessitate enucleation.

The age and sex of the patients in this group and the interval between the discovery of the detachment and enucleation are presented in tables 1 and 2. From these data it is evident that there is no special time for the onset of iritis and glaucoma.

*Lacerations and Holes.*—If in a slide an isolated and separated tag of retinal tissue is found attached to the choroid or sclera in the neighborhood of a defect in the retina, one may consider that this identical piece of retina marks the original site of the retinal aperture. This is taken as evidence that a genuine hole and not a mere tear is present. As a further mark of differentiation, the edges of a retinal tear are frequently more curled than the edges of a hole. Dehiscence in the neighborhood of an opening points to a tear rather than to a hole. Finally, a differentiation may have to be made between a primary laceration which has brought about detachment and a secondary laceration which has occurred in the presence of an already developed detachment. A probable example of secondary laceration is shown in figure 28 (case 41).

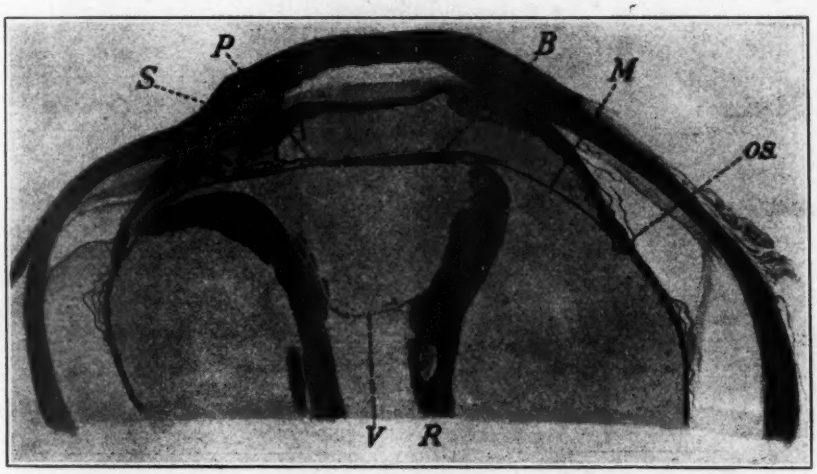


Fig. 1 (case 2).—Drawing of the enucleated eye of a woman aged 24. Detachment of the retina had occurred twelve years before enucleation, and extraction of the lens was done four months before. Tension was —1, and the eye was blind. The highly degenerated retina (*R*) is shown torn away on the right side from the ora serrata (*OS*). The large opening is closed by a fine homogeneous membrane, which is covered posteriorly by cells, reminding one of epithelium (*M*). The vitreous is detached anteriorly and runs from the anterior edge of the torn retina to the ciliary body of the opposite side, where it is covered by a proliferation of pigment (*P*), whereas on the right the anterior surface of the vitreous is pervaded with blood (*B*). The vitreous is posteriorly detached (*V*) and also contains a little blood. The lens is absent, and to the left the scar of the operation is visible. Although the tension was minus at the time of enucleation, the protruded iris and retina make it likely that there was increase in tension at a former period.

Altogether, there were 10 cases in which there were tears in the retina. In 5 of them the tear was at the ora serrata and in 5 it was

posterior to it. In addition, there were 3 cases in which there were holes, in 2 of which an idea of the diameters was obtained from the size of the piece of retina that remained adherent to the choroid. The tear showing the greatest amount of gaping measured 8.5 mm. across (fig. 19). In 1 case a hole was situated at the macula and was combined with a tear at the ora serrata.

In 28 cases no tear could be found, but it was borne in mind that a tear could have been present in other parts not available for examination. It is possible for a tear to disappear after a long time owing to secondary changes in the surrounding area. Indeed, in cases in which detachment had existed over a long period the tears were regularly closed and obliterated by various kinds of membranes.

*Duration of Final Inflammation and Pain.*—In 8 cases there was a note in the history regarding the onset and duration of the final inflam-

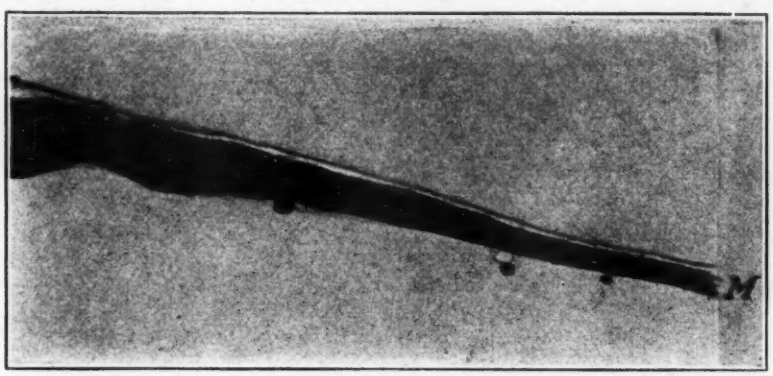


Fig. 2.—Detail of figure 1 *M*. The membrane (*M*) closed the aperture between the torn retina and the ora serrata. It consists of a more or less homogeneous, darkly stained tissue covered by a row of cells. Where the membrane is thicker, the row of lining cells loses its regularity. It is probable that the homogeneous membrane originated from the vitreous and the lining cells from endothelium.

mation and pain. In 5, only a few days transpired; in 3 others, two, three and six weeks respectively were recorded.

*Lack of Traumatic Detachments.*—It was astonishing, as has been mentioned before, that in this material there were only two eyes in which detachment occurred after trauma, in one after an incision and in the other after extraction of cataract.

## CAUSES OF RETINAL DETACHMENT

Since cases of retinal detachment are now being studied more carefully, an increasing number of lacerations and holes are found. Special attention is being paid to the state of the vitreous, detachment of which,

although seen and reported by von Graefe, never attracted great interest. The question as to the etiology of detachment of the retina with holes or lacerations is still a matter of controversy. Therefore, it seemed advisable to divide the material here used into two groups: detachments occurring in association with holes and those occurring after laceration.

Since the time of Leber laceration of the retina has been a subject of interest. Fluid from the vitreous is supposed to pass by way of an opening into the subretinal space, thus mechanically separating the retina from the choroid. More modern studies have concentrated on the etiology of the development of the opening, and a large number of theories have been brought forth. Leber's idea was that on the flat part of the ciliary body a fine inflammatory membrane develops and

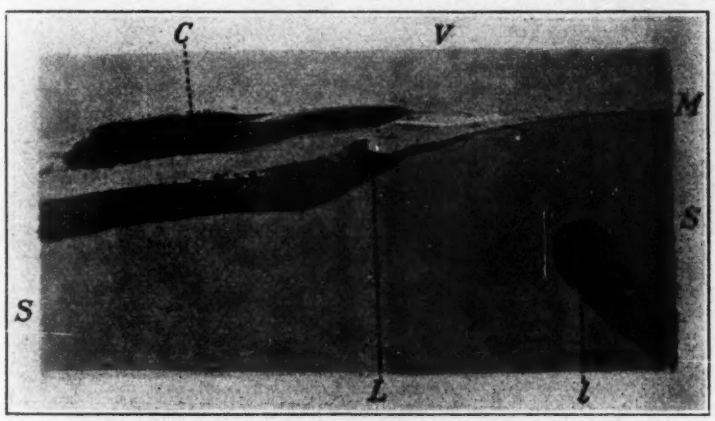


Fig. 3 (case 5; detail of Klien's preparation; case 10 of Lindner's series).—Drawing of a section of the enucleated eye of a man aged 24 years in whom one year before enucleation spontaneous blindness suddenly developed in the left eye. There was no pain or inflammation until a few weeks before enucleation. A clinical diagnosis of retinal detachment with secondary glaucoma was made. Enucleation was done because of the pain. To the left is shown the ora serrata (*S*). Between *L* and *l* lies a hole in the retina. The posterior lip is blunt. The nuclear rows turn inward. The anterior lip (*L*) is pulled out and passes into a fine membrane (*M*), which outlines the detached vitreous (*V*) from the subretinal fluid (*S*). In front of the anterior lip is the former covering of the hole(*C*), the medial edge of which is connected by fine fibers with the membrane.

creeps backward to cover the inner surface of the retina, which process he called preretinitis. Belief in the lacerating action attributed by him to this membrane has been generally given up, and preretinitis, as understood by Leber, is now considered to be an effect of a secondary inflammation that develops slowly after detachment has already taken place.

THEORIES AS TO THE CAUSES OF DETACHMENT

*Traction of the Detached Vitreous (Gonin's Theory).*—It was Gonin's [2] belief that the vitreous was mainly to blame. His idea was that, first, there took place a posterior detachment of the vitreous, which exerted traction on the retina anteriorly. This theory has been accepted by many, Lindner [3] among the number. The facts that the vitreous is found to be so frequently detached posteriorly and that the lacerations

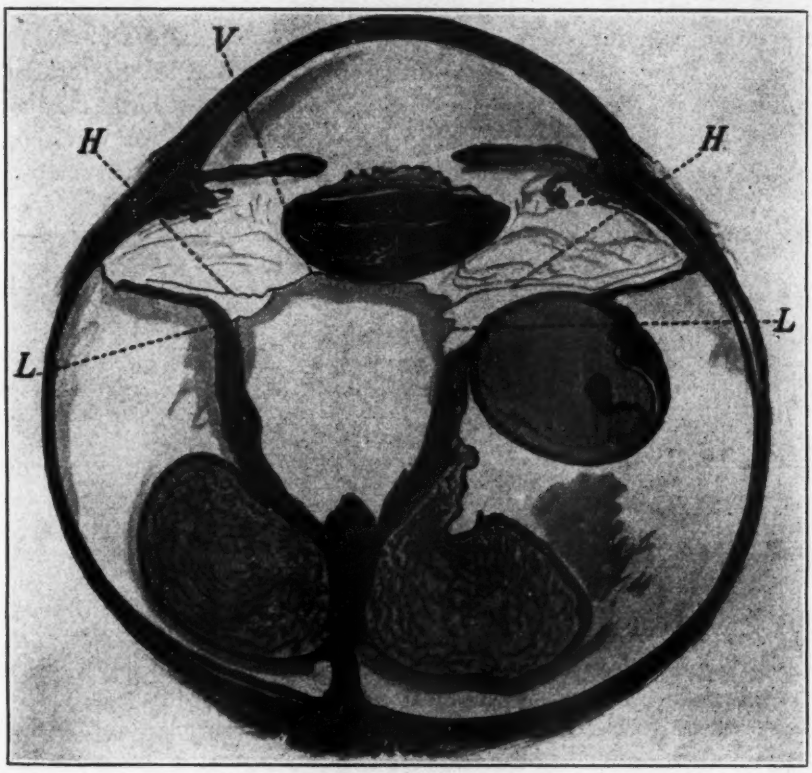


Fig. 4 (case 8).—Drawing of an enucleated eye with complete detachment of the retina and three large cysts on the external surface. The vitreous (*V*) is shown posteriorly detached and lying compressed behind the lens, where it is enclosed by a membrane which divides into two other membranes, one of which corresponds to the hyaloid membrane of the vitreous (*H*) and the other of which corresponds to the membrana limitans interna of the retina (*L*). The lens shows a pyramidal cataract.

of the retina are as a rule far in front and concentric with the ora serrata are in favor of Gonin's theory. The position of the laceration

2. Gonin, J.: Le décollement de la rétine: Pathogénie; traitement, Lausanne, Payot & Cie, 1935.

3. Lindner, K.: Zur Klinik des Glaskörpers: III. Glaskörper und Netzhautabhebung, Arch. f. Ophth. **137**:157, 1937.

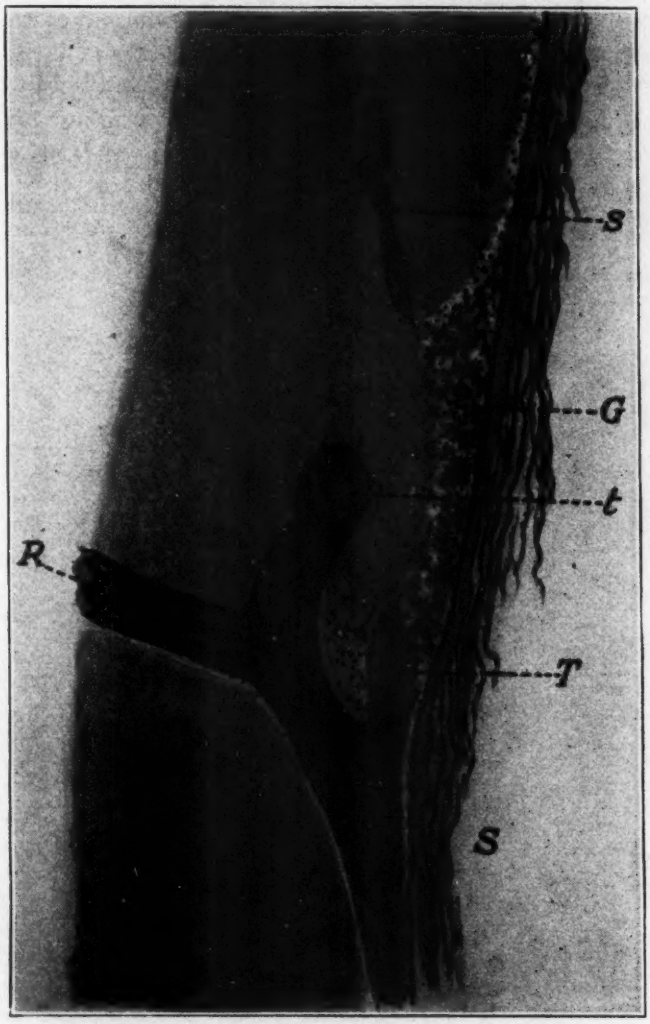


Fig. 5 (case 9; detail).—Drawing of a section of the enucleated eye of a woman aged 29. She had always been very near sighted and became blind in this eye twenty years before enucleation, after lifting a heavy weight. Six days before the eye became red and painful and the cornea dull. The anterior chamber was deep and the lens opaque. Tension was + 2. An isolated bleb-shaped detachment occurred at the equator (not seen in this section). Posteriorly at *S* is shown a synechia between the highly degenerated retina and the atrophic choroid. At the place where the detached retina (*R*) separates from the choroid a hyaline tuber (*T*) is situated. It is a product of the pigment epithelium and a sign of reaction by it to the pulling of the retina. Another tuber (*t*) shows an adhesion of the retina that was torn away by the detachment. A similar remnant of such a synechia is demonstrated by a little shred of retina (*s*). The pigment epithelium is covered by a layer of ghost cells (*G*).

behind the ora serrata coincides with the region in which the base of the vitreous, which is intimately connected with the anterior part of the retina, passes into the posterior limiting membrane of the vitreous. This is the exact zone in which the detached vitreous is likely to exert a pull on the retina, if there really is traction.

This theory is supported by the fact that a majority of retinal detachments start superiorly, where pulling on the vitreous should nat-

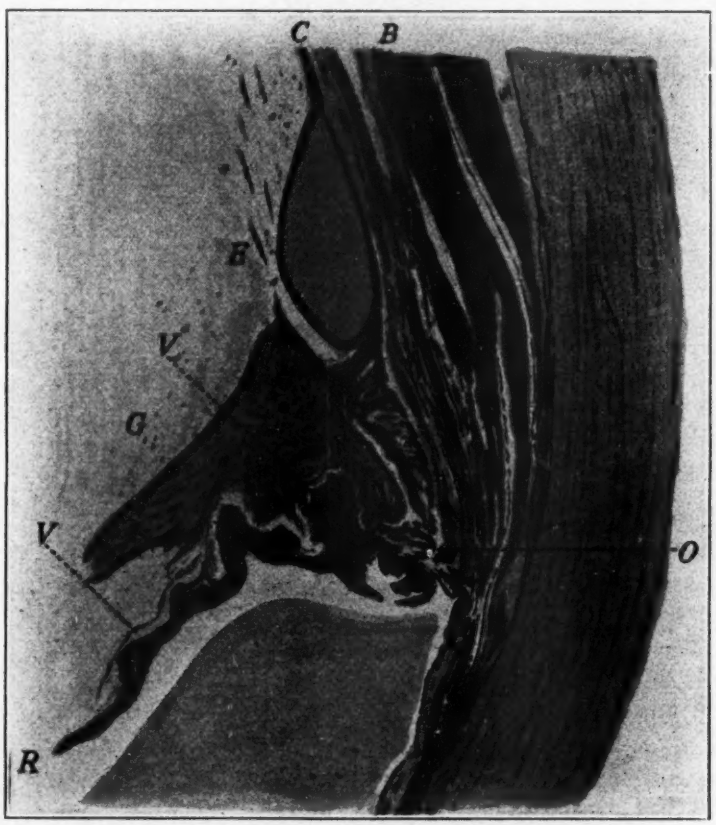


Fig. 6 (case 11).—Drawing of the enucleated eye of a man aged 68 which had been blind for many years. Lately it became inflamed and painful. The lens was cataractous. Transillumination gave negative results. Tension was + 3. An intraocular tumor was suspected. The ciliary body (*C*) is shown separated by blood from the sclera. The detached retina (*R*) is exceedingly atrophic and degenerated. Between this and the detached ciliary epithelium (*E*), granulation tissue (*G*) is situated, which comes from the ora serrata and fills the triangular space between the flat part of the ciliary body and the retina. Between the retina (*R*) and the granulation tissue (*G*) a transparent coiled membrane is visible, which follows the inner surface of the retina and corresponds to the collapsed vitreous (*V*). Behind the ora serrata (*O*) is a concretion of chalk which, like the granulation tissue, is probably an effect of traction exerted by the detached retina.

urally be most active. In this connection it is recalled that lacerations of the retina are more frequently encountered above than below. To be more exact, a majority are situated in the upper outer quadrant, near the ora serrata. The insertion of the tendon of the superior oblique muscle in this quadrant is thought by some to be a factor in the causation of detachment, the theory being that in the act of contracting, the muscle, by means of its tendon, actually distorts the underlying layers at the place of insertion of the tendon. In anatomic preparations, as a sign of traction one sometimes observes a step in the detached retina at the place where the detached vitreous leaves it. This happens even when the posterior surface of the vitreous shows no fibrous membrane. This is demonstrated in figure 10 (case 14), in which only a few isolated cells lie on the hyaloid membrane.

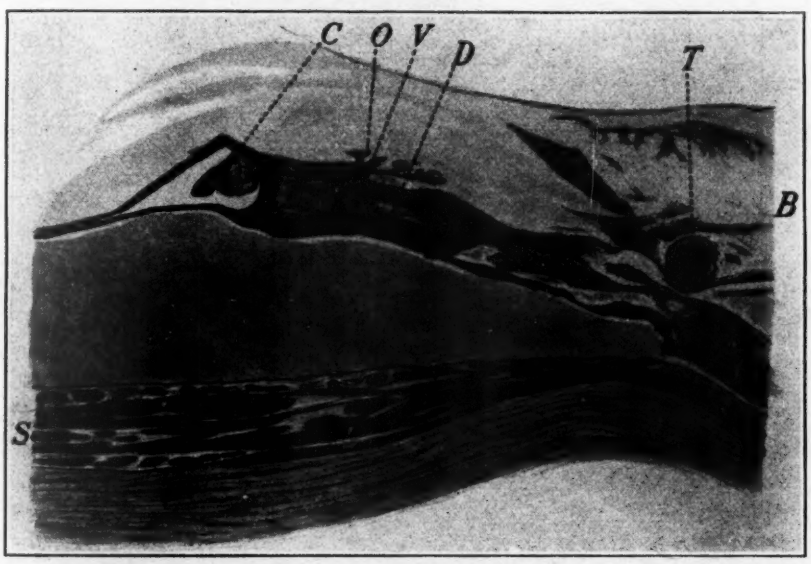


Fig. 7.—Drawing of a section of the eye shown in figure 6. Excessive degeneration of the retina is apparent. To the left are seen only fine glial pellicles, which form a cyst (*C*). To the right is a loose cystic spongy tissue with hyaline masses, remains of vessels (*V*) and chalk deposits (*D*). Areas with large collapsed cysts are seen. The retina is covered by a shrunken vitreous body (*B*), which shows various cellular elements, even a tuber-shaped hyaline concentration with pigment (*T*). At *O* organized strands of tissue have grown into the vitreous. The choroid shows small drusen of the lamina vitrea and elevation of the pigment epithelium. The subchoroidal space (*S*) is full of blood.

*Cystic Degeneration (Vogt's Theory).*—According to the theory of Vogt,[4] cystic degeneration of the retina is the greatest factor in its detachment. Without doubt cystic degeneration does play a great role

4. Vogt, A.: Die operative Therapie und die Pathogenese der Netzhautabhebung, Stuttgart, Ferdinand Enke, 1936.

in dehiscence of the retina, which perhaps is more related to the development of holes than of tears. One can easily imagine how in the neighborhood of one hole fresh holes develop, so that a cribriform condition of the stroma arises.

On the other hand, one should not forget that cystic degeneration is exceedingly common near the ora serrata and that by no means can

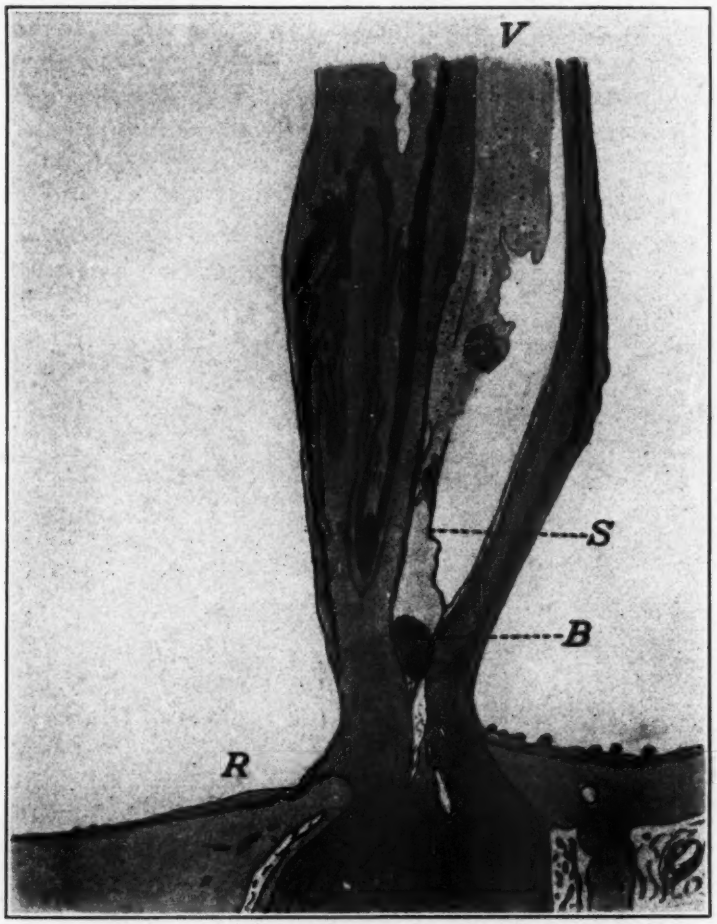


Fig. 8 (case 12).—Drawing of a section from the enucleated eye of a woman aged 37. The retina became detached nine years before enucleation. A combination of glaucoma and retinal detachment pushed the retina into the excavation. To the left is seen a tag of retina (*R*) on the choroid, a sign of a temporal conus. The retina is fully detached, and the chalice-shaped interior is filled with blood (*B*). The vitreous (*V*) fills the chalice and extends far into the depth. A shred (*S*), which is a continuation of the vitreous, is inserted on the opposite side of the retina. A number of drusen rise from the choroid.

this be considered as the only cause of detachment. The common senile cystic degeneration, which may be seen occasionally with the ophthal-

moscope when it reaches far backward, usually exhibits under the microscope a solid membrana limitans interna, which prevents communication between the cystic spaces and the vitreous. The cystic degeneration, which according to Vogt is the main cause of retinal detachment, is probably of a different type from that of Blessig's spaces at the ora serrata. It is certainly not the only cause of all detachments, perhaps not even the most common cause, although it is a typical and only cause of a certain group of detachments.

*Stretching of the Retina in Myopia (Hanssen's Theory).*—In 1919 Hanssen published reports on a number of slides to show that in cases of high myopia the retina is put on the stretch and that defects develop from stretching. Recently A. Fuchs [5] published the report of a case of high myopia in which areas along retinal blood vessels were considerably attenuated, so that it became obvious that in these spaces later the

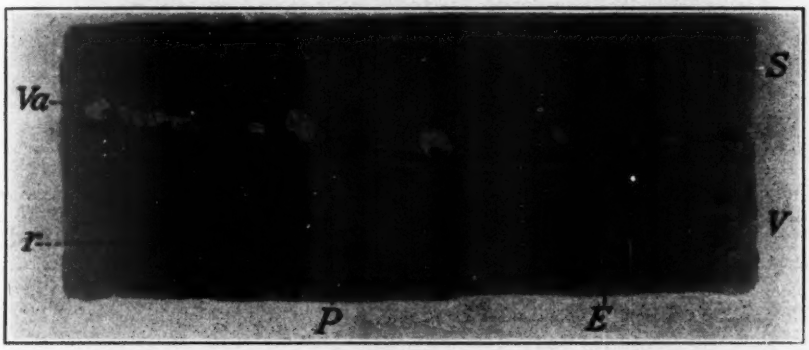


Fig. 9 (case 13).—Drawing of a section of an enucleated eye with detachment of the retina of three years' duration. It is hard to differentiate the posterior surface of the posteriorly detached vitreous (*V*) from the subretinal fluid (*S*). A few elongated nuclei (*E*) are present on the posterior surface, and some phagocytes (*P*) containing pigment are seen. Vacuoles (*Va*) in the subretinal fluid are a characteristic artefact. In the vitreous itself are a few isolated round cells (*r*). Anteriorly the retina was torn away together with a flap of ciliary epithelium.

tissue could entirely disappear, forming holes on either side of the vessels. His explanation was that stretching of the retina in cases of high myopia may cause holes to develop, which are sometimes found on either side of a blood vessel. He referred to Hanssen's statements and spoke of the neglect into which the theory of stretching of the retina in myopic eyes has fallen.

*Congenital Weakness as a Factor in Traumatic Detachment.*—Since cases of detachment of the retina have been carefully studied it is

5. Fuchs, A.: Ueber Netzhautzysten und über die Entstehung von Netzhautlöchern, Klin. Monatsbl. f. Augenh. **98**:145, 1937.

astonishing how frequently laceration at the ora serrata has been discovered, whereas formerly one rarely heard of, and practically never saw, a laceration.

Oral tears and large lacerations in the anterior part of the retina are characteristically found in cases in which there is a history of slight injury. The eye itself is not always directly injured. Sometimes a contusion of the head or intense and continuous motion of the whole body, as when riding a motorcycle, is the cause. Diving from a great height

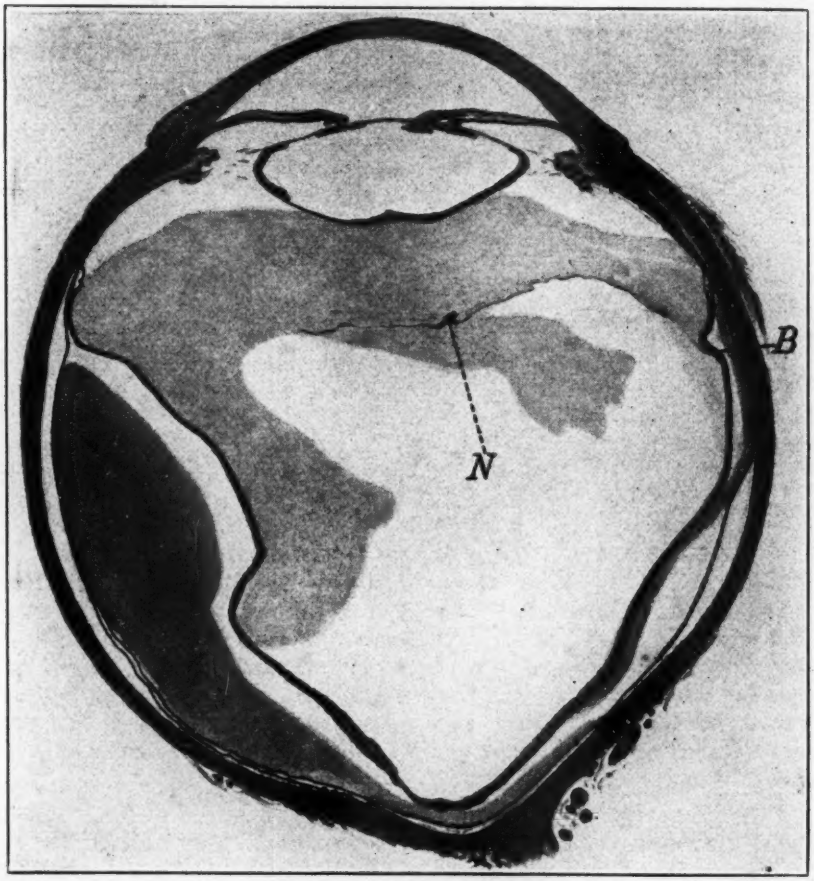


Fig. 10 (case 14).—Drawing of the enucleated eye of a woman aged 73, who had always had poor vision. She had an iris bombé with inflammation and pain for four days, and the tension was + 2. The drawing shows a flat detachment of the retina and a tangential section through a circumpapillary excavation due to secondary glaucoma. Iris bombé is present. The vitreous is detached. The posterior outline to the left side cannot be seen. To the right side, the hyaloid membrane is visible. In the center is a piece of the surface of the retina which was torn away by the contraction of the shrinking vitreous. At *B* is the base of the vitreous, and here the detached vitreous has caused a slight step in the retina. No laceration is seen. *N* shows neuroglia tissue torn from the retina.

has been known to lead to bilateral detachment. It is clear that not the blow alone or the traction by the vitreous during or after slight concussion of the head can by itself produce retinal detachment, otherwise it would be more frequent. There must be a special congenital weakness in the retina of some persons. Such local congenitally weak spots are familiar. In ophthalmology one is reminded of the bilateral formation of a hole in the macula after injury, the occurrence of which has been reported several times. An example in other parts of the body is the development of hernia on the basis of congenital weakness. That congenital weakness plays a role in cases of retinal detachment after slight traumatism becomes all the more evident when one considers that in many of these cases the detachment is bilateral. Sometimes the place of weakness may be small and circumscribed and some-

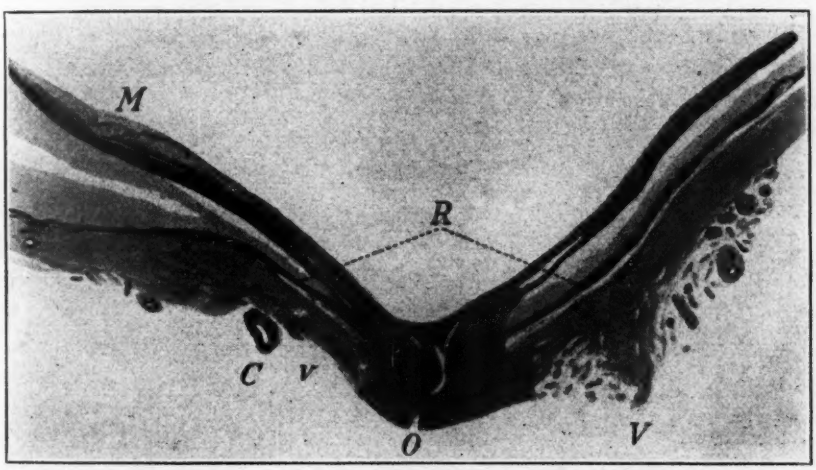


Fig. 11.—Drawing of a section of same eye shown in figure 10. There is present not only pathologic excavation (*O*) but a circumpapillary ectasia. At *v* and *V* is the intervaginal space of the optic nerve. The retina is detached, but in the neighborhood of the papilla a layer of retina (*R*) remains stuck on the sclera in the area of the circumpapillary atrophy of the choroid. The choroid and the pigment epithelium begin at the same point. The vitreous is detached posteriorly (fig. 10), and the membrana limitans interna has remained on the retina and is visible near *M*, separated and somewhat thickened. The posterior ciliary vessels (*C*) are markedly sclerotic.

times large. This would explain why it is that an operation on an oral tear is successful in 1 case, with no return of the detachment, while in another case a fresh dehiscence is formed near the oral tear.

A borderline between cases of spontaneous and of traumatic detachment cannot be sharply drawn because an injury may be so slight that while one might count it as an etiologic factor, another might deny any traumatic factor. Furthermore, as many of the nonmyopic detach-

ments are bilateral and show even symmetric lacerations, a congenital constitutional factor could hardly be denied. Probably this consists in a friability of the retina. Otherwise, hereditary detachment could not easily be understood.

Instances are known in which myopic detachment of the retina develops in one of the parents, and one child inherits myopia but detachment does not develop. Another child who is nearly emmetropic may yet have a detachment. This supports the theory that a detachment may originate on the basis of a congenital disposition and that this hereditary disposition is especially likely to manifest itself in cases of myopia.

*Detachment Caused by Retinal Cysts (Weve's Theory).*—In recent years Weve and a few others have published reports of cases in which retinal cysts had separated the retina from the choroid and led finally to laceration and detachment. Weve concluded that this etiologic factor is by no means rare and leads regularly to a general detachment.

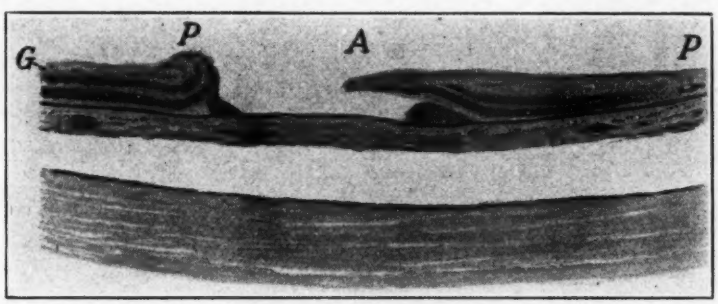


Fig. 12.—Drawing of a section of an enucleated eye. At 14 mm. from the temporal side of the papilla there is a perforation in the retina. The posterior lip (*P*) is turned inward. The anterior lip (*A*) is sharp and consists only of the anterior layers. Between the lips and the pigment epithelium, a small amount of albuminous fluid is collected. The ganglion cell layer (*G*) is atrophic. Anterior to the hole, gliosis of the retina with some pigment (*P*) can be seen. A detachment of the retina did not follow, although no adhesions between the retina and the choroid are present.

Anatomic reports of cysts of this type occur in the literature. In 1 case the cysts were bilateral, and yet they had not led to general detachment. Judging from this, it would not seem to be urgent to operate for every large retinal cyst as long as the retina is not widely detached, because a cyst may cease to grow before the retina is torn away at the bulging spot. It is likely that certain cases of detachment in which some vision remains for a long time are more frequently caused by retinal cysts than is suspected. Cases may occur in which a detachment due to choroidal sarcoma has been combined with laceration of the retina. The presence of a tear does not exclude the presence of a tumor.

*Retinal Detachment Without Lacerations.*—There is no doubt that in many cases a laceration may exist which is not seen clinically, either because the opening is extremely small, does not stand out prominently or is too peripheral or because it lies in the shadow of a fold or between two folds or on a place where the retina has become reattached and the hole inconspicuous. From clinical experience, it is exceptional not to discover an opening.

It is possible that the fluid by which the retina is detached can be produced either by the choroid, the pigment epithelium or the retina.

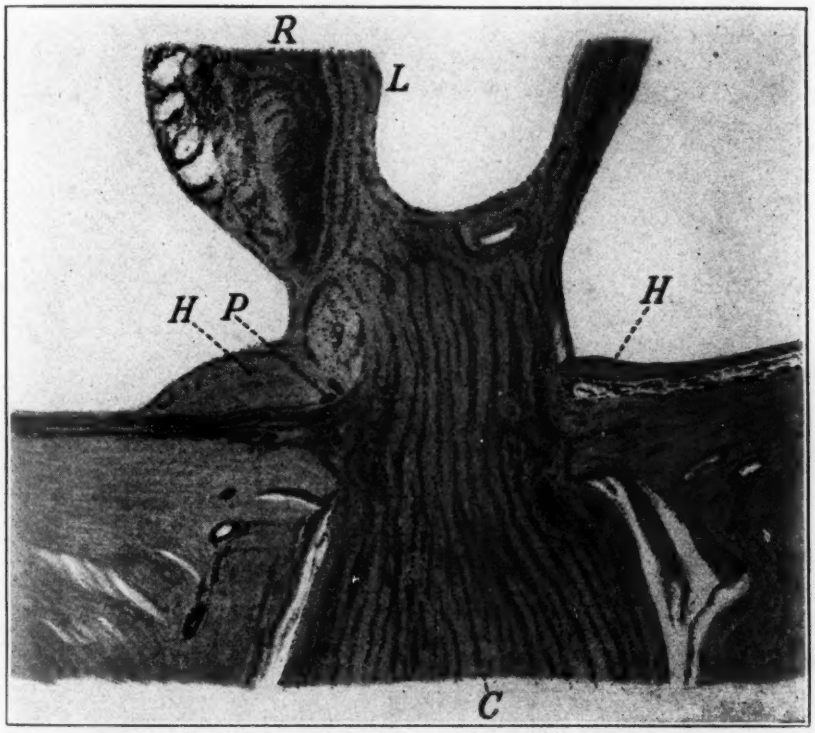


Fig. 13 (case 16).—Drawing of a section of an enucleated eye. The retina was totally detached and a large *Ringschwiele* lay on the ciliary body (not seen). The retina (*R*) is thick on the left side because a fold was cut tangentially. Cystic degeneration is visible; on the right, only the inner nuclear layer is present (gliosis). At *L* the membrana limitans interna is detached. Surrounding the papilla is a hyaline membrane on the choroid covered by pigment epithelium which has lost its granules (*H*). Near the optic nerve two islands of densely pigmented epithelium are present (*P*). The papilla is atrophic. The lamina cribrosa (*C*) is recessed.

If the choroid produces the fluid, especially one as rich in albumin as is the fluid found in the subretinal sac, one would expect to encounter pathologic changes in the choroid and a detachment of the pigment

epithelium. The pigment epithelium has been suspected of having the power to produce an albuminous fluid. This theory is based on the presence of tiny vacuoles along the inner border of the pigment epithelium. It is likely that such vacuoles are the result of the action of the fixation fluid, because they are seen under many different circumstances. It is probable that the albuminous fluid is produced in the retina itself, brought about either by a shrinkage of the retina or by a primary production of fluid. Perhaps both occur and for this reason detach-

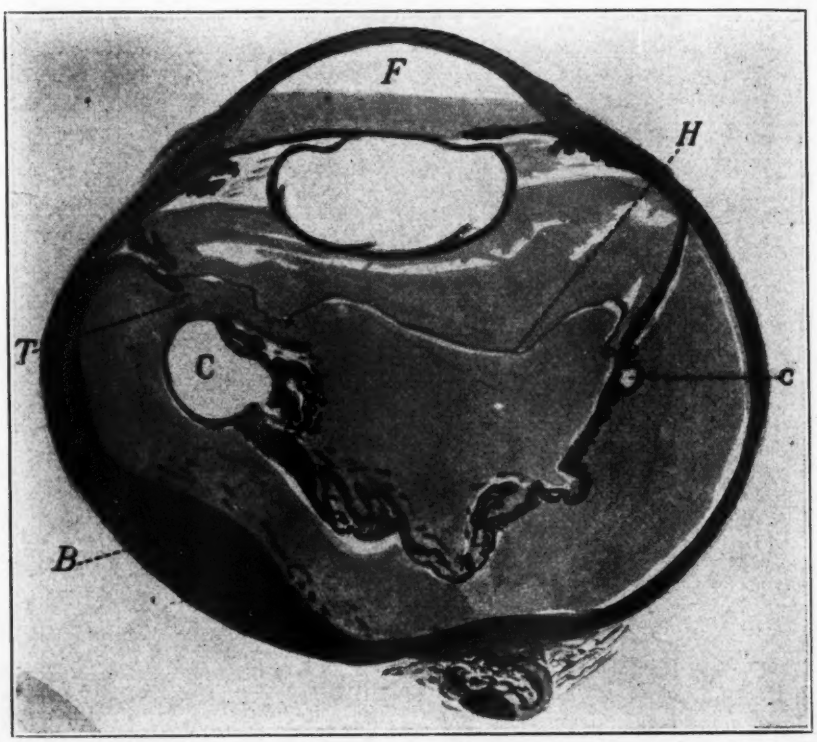


Fig. 14 (case 18; case 6 of Lindner's series; preparation from Meller).—Drawing of the enucleated right eye of a woman aged 54, which was removed because sarcoma was thought to be present. The vitreous is entirely detached, and the hyaloid membrane (*H*) runs from the anterior lip of the tear (*T*) toward the opposite retina. A large cyst (*C*) takes in a large area of a dehiscence. A small cyst is present at *c*. Behind the insertion of the hyaloid membrane marked cystic degeneration took place in a fold of the retina. Blood (*B*) lies on the choroid and on the inside of the retina. The peripheral anterior synechia on the right and the albuminous fluid in the anterior chamber are signs of iritis.

ments which occur without a hole or laceration offer such a poor prognosis for operation, whereas, theoretically, they should offer a much better prognosis.

PRIMARY ANATOMIC CHANGES IN THE RETINA

*Localization of Holes and Lacerations.*—Altogether ten tears and three holes were found in the material used for this study. Five of the tears were near the ora serrata. Of the entire ten tears, a history of myopia was mentioned in connection with only two. In 1 of these eyes anatomic changes were observed which were in favor of myopia in life, whereas of the eyes with holes, only 1 showed anatomic evidence of myopia. This was in a case of hydrophthalmos in which it was believed that a stretching of the retina took place similar to that in myopia.

Tears at the ora serrata were all much larger than those farther back, which is consonant with clinical findings. Nearly all of the holes and tears at the anterior part of the retina were closed either by the vitreous

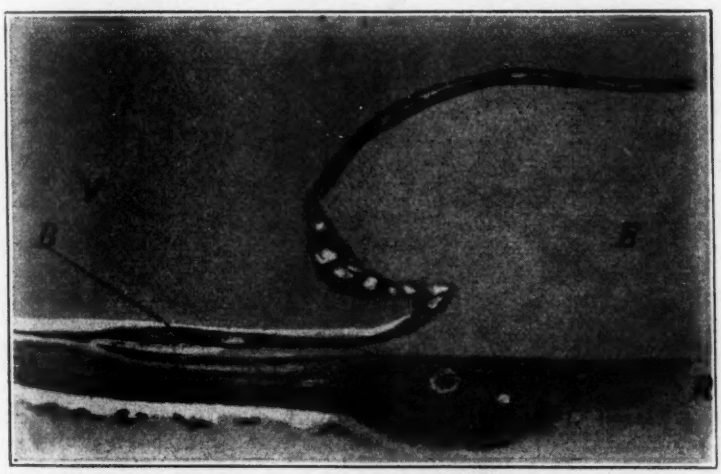


Fig. 15 (case 20).—Drawing of the enucleated left eye of a man aged 28, which was blind for eighteen years. Five weeks before enucleation the patient received a blow with a piece of wood, which caused contusion. Since then there had been inflammation and pain. The cornea was dull, and the anterior chamber was abolished. The pupil was closed by a membrane. Tension was + 3. Excessive degeneration (gliosis) of the retina (*R*) is shown. The vessels contain pigment. Between the vitreous to the left (*V*) and the subretinal fluid (*E*) a membrane runs in folds, which contains a large number of cystic spaces, revealing its neuroglia nature. Blood lies between the retina and the vitreous (*B*).

or a fine membrane behind the vitreous or by a real neuroglia growth. Only one hole, that in the macular region, did not have a veil over it.

In this connection it is worth while calling attention to one preparation (fig. 12), although it is not included in the material used for this study. The hole is located about 15 mm. to the temporal side of the papilla, beyond the macular region. It demonstrates that spontaneous

holes can develop without detachment necessarily following. Glaucoma was probably present here, but just how an increase in tension may press the retina against the choroid is not understood.

Twice in this material there was observed an original piece of retina which remained after the hole formed. In the first case, in which anatomic myopia most likely existed, the piece adhered to the choroid, which showed a dense infiltration corresponding to the synechia (fig. 29, case 32). Here certainly the hole was not the true cause of the detachment but, on the contrary, was the result of the detachment in which, at the start, there was traction, then inflammatory reaction from traction and lastly detachment with the formation of a hole. In the second case (Dr. Klien's case 10 of the Lindner series), the piece of retina was

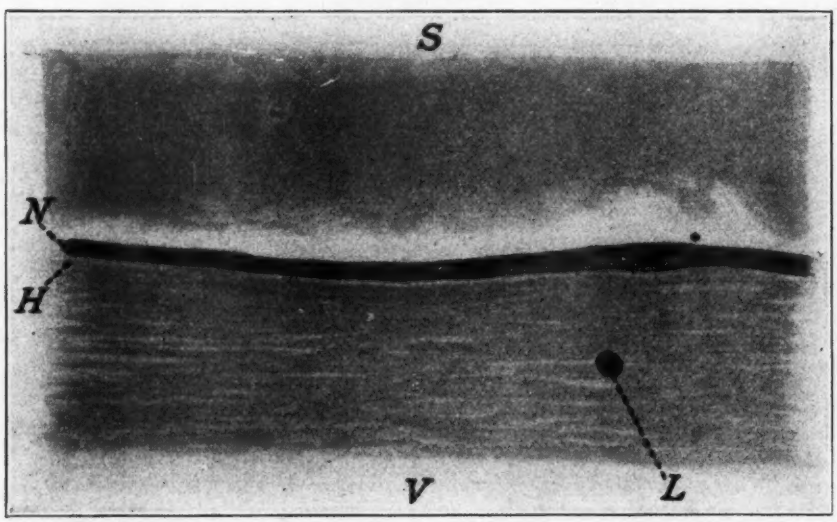


Fig. 16.—Drawing of a section of the same eye shown in figure 15. The vitreous (*V*) is recognizable by its undulating structure. The hyaloid membrane (*H*) is covered by a cellular layer, which reminds one of epithelium because of its regular nuclei, but most likely it comes from the neuroglia (*N*). In front of this cellular layer the subretinal fluid (*S*) is visible. A swollen lymphocyte (*L*) lies in the vitreous.

dislocated above and to the inside of the detached retina (fig. 3, case 5). Lindner presented this case to strengthen Gonin's theory of traction by the vitreous. According to Gonin, the traction is greatest along the posterior border of the base of the vitreous, so that a fragment of retina going off with the detached vitreous would be misplaced toward the center of the globe. But here the fragment lies anterior to the hole, which would point to traction exerted from a point in front of the base of the vitreous.

*Changes in the Vitreous.*—Confirmatory of Gonin's theory is the fact that in the present material posterior detachment of the vitreous was found in 23 cases. In 5 cases there was no posterior detachment, suggesting that by no means is posterior detachment of the vitreous an absolute necessity for detachment of the retina. A characteristic posterior detachment is shown in figure 14 (case 18). In contradistinction, an example of how the vitreous retains its posterior attachment is shown in figure 8 (case 12), where some of the vitreous between the collapsed retina is connected with the papilla by fine strands. Twice anterior detachment of the vitreous was associated with posterior detachment, as is visible in figure 1 (case 2), in which an oral tear is closed by vitreous.

In 2 cases there was an anterior detachment of vitreous alone. In 4 cases the vitreous was so completely detached posteriorly that it lay as a shrunken membrane behind the lens, as illustrated in figure 4 (case 8).

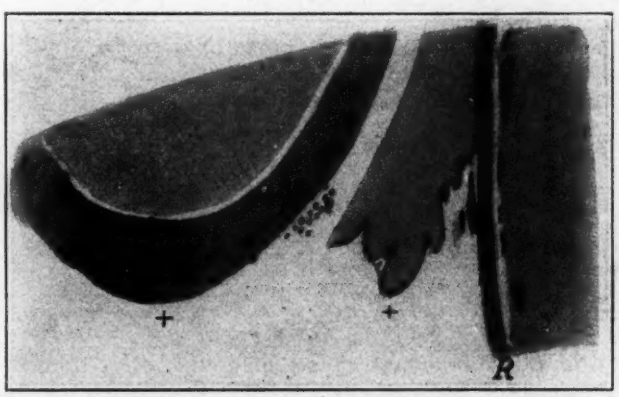


Fig. 17.—Drawing of a section of the enucleated eye shown in figure 15. To the right the degenerated retina (*R*) is covered on both sides by blood. To the left a fine membrane detaches itself from the retina and goes off with the vitreous body, outlining its posterior surface. To the left a detail is drawn. One sees homogeneous stratum in which round and oblong cells of different size are scattered. The shape of the nuclei and the texture of the parenchyma make it certain that this membrane originated from neuroglia.

In 1 case granules of pigment lay on the posterior surface of the detached vitreous. Marked hemorrhage occurred within the vitreous in 2 cases, and there were large opacities of the vitreous in 3. Twice blood vessels had invaded the vitreous. In cases of recent detachment the vitreous is probably free of cells on its posterior surface, the formation of a membrane being a secondary process.

*Relation of Vitreous to the Margins of Retinal Apertures.*—In a special case (fig. 9, case 13) the retina was not torn away just at the ora serrata itself but at a short distance in front of it, leaving a tag of ciliary epithelium hanging freely on the flat part of the ciliary body, as if the

ciliary epithelium had been drawn away by the retina and then ruptured secondarily. It is doubtful whether traction by the vitreous could have caused such an extensive detachment. In 2 cases the vitreous was far anterior to the tear, having been drawn up to the posterior surface of the lens. The hole in the macular region, already referred to, developed independently of the vitreous. Three lacerations near the ora serrata revealed an adhesion between the tip of the anterior lip and the hyaloid membrane of the vitreous. One of the cases was interpreted as being in support of Gonin's theory. Lindner used the other 2 cases in support of the same theory. In connection with the first of these 2 (fig. 3, case 5), it is to be recalled that the fragment of retina was in front of the aperture. It did not seem possible to prove exactly what had happened, although the detachment was as recent as one year. The second case (fig. 14, case 18) corresponds to case 6 of the Lindner series, regarding which he stated that it fulfils all the requirements of Gonin's teaching,

TABLE 3.—*Changes in the Vitreous in Material Studied*

| Appearance of Vitreous | No. of Cases |
|---|---|
| No detachment | 5 |
| Posterior and anterior detachment | 2 |
| Anterior detachment alone | 2 |
| Posterior detachment | 23 |
| Deposits of pigment | 1 |
| Opacities of the vitreous | 3 |
| Hemorrhage | 2 |
| Delicate vascularization | 2 |
| Organized membrane | 2 |
| Vitreous not visible | 4 |

the flap of the laceration passing imperceptibly into the hyaloid membrane. In figure 14 it will be seen that three fourths of the tear is taken up by a large cyst, which was probably the reason that it was suspected clinically that a tumor was present. It would seem more likely that the cyst was the cause of the traction that induced the tear rather than the detached vitreous.

*Inversion of the Lips of a Laceration.*—Clinically, one is accustomed to seeing the free margin of the anterior flap of a laceration, especially of the horseshoe-shaped type, curled inward. Histologically, one often finds the posterior margin of the aperture to be likewise curled inward. In explanation, the inner layers of the retina, especially the nerve fiber layer and the membrana limitans interna, seem to have a greater elasticity than the external layers, which are so rich in nuclei that they are not so contractile as the less nuclear internal layers.

*Cystic Degeneration Near and Far from a Hole.*—Circumscribed cystic degeneration was found in 8 cases but never in a degree comparable to that often seen in cases of secondary detachment of the retina. Sometimes the cystic degeneration was near a pulling membrane; some-

times it was in a fold in which the retina was sharply bent by adhesions. Particularly striking was the rarity of typical cystic spaces in the neighborhood of lacerations and holes. However, in the very anterior lip of one laceration cystic degeneration was present (fig. 29, case 17), and it was believed to be the main factor in the causation of the detachment. The common cystic spaces at the ora serrata, the importance of which in the origin of detachment is probably overestimated, were missed in many cases. It is possible that stretching of the retina is not favorable to the formation of this type of degeneration.

In another case typical cystic degeneration was found near a hole (figs. 26 and 27, case 39). There is no denying that cystic degeneration

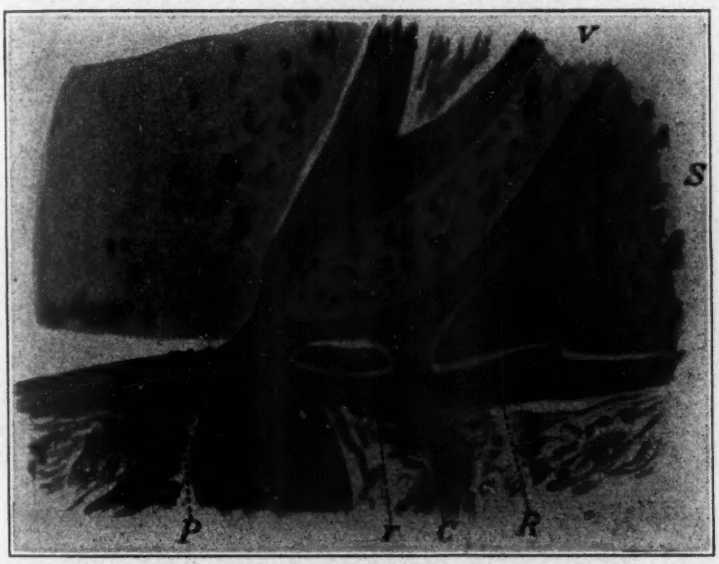


Fig. 18 (case 23).—Drawing of a section of the enucleated eye of a man aged 59. Four years before enucleation, after an increase in myopia, both eyes suddenly became blind. The papilla is drawn to one side. The retina is adherent to the choroid on the right side, and on the site of the adhesion a cyst (*C*) has formed. On both sides of the synechia parts of retinal tissue (*r* and *R*) are left. To the left a slight retraction of the papilla and a pigment crescent (*P*) are visible. Abundant hemorrhages in the subretinal space (*S*) and in the vitreous cavity (*V*) are seen.

is an important etiologic factor in retinal detachment, yet judging from this survey it is far from being the most frequent cause.

In 1 case a hemorrhage in the retina destroyed the tissue near the tear. It is likely that the hemorrhagic destruction happened later as a secondary change, but still it would not seem impossible that a hemorrhage in the retina may cause a hole in rare instances. Clinically, a red spot, which at a glance may appear to be blood, turns out to be a hole.

*Large Cysts of the Retina.*—Once a pseudocyst was found, by which is meant a space walled in by retinal folds and containing a fluid differing in albuminous content from that in the subretinal space. In 12 cases large cysts were found, of which two lay in the retina itself. The latter were of no great interest in this paper because they represented a splitting of the tissues and not a real cyst. They occurred mostly in highly degenerated retinas. Large spaces caused partly by traction are illustrated in figure 7 (case 11). In 4 of the other 10 cases there were small cysts on the outside of the retina, of which one was in the embrace of a fold

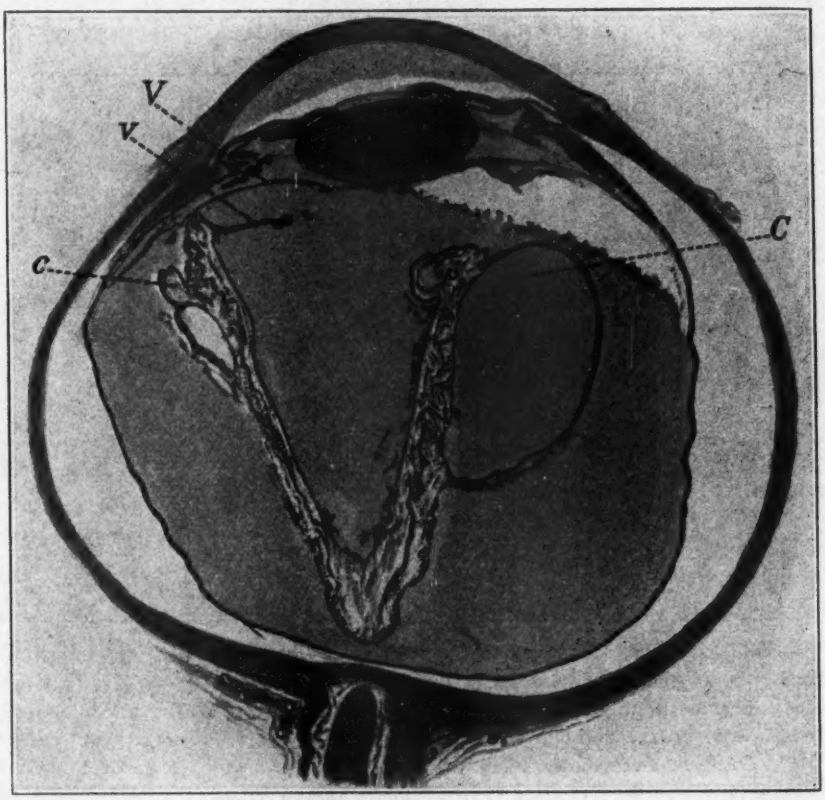


Fig. 19 (case 25).—Drawing of the enucleated eye of a boy aged 9 years. The fellow eye showed —12 D. of myopia, the myopia probably being congenital. The retina is torn on the right side, and immediately behind a huge cyst (*C*) is visible. The vitreous (*V*) is collapsed behind the lens. A thread of the retina is at *v*, and a small cystic space (*c*) is on the outside of the retina on the left. The lens shows a complicated cataract. In the pupillary area the border of the iris is fixed to the lens. On the right side there is a wide disinsertion of the retina. The cyst appears to have caused the disinsertion by expansion outward.

(similar to that at *c* in figure 14). In the remaining 6 cases the cysts were large and likewise on the outside of the retina. These cysts were situated on several separate places.

Cysts in 4 cases were of particular interest in that possibly they belonged to Weve's group. In 1 of these cases (fig. 4, case 8) the detachment seemed to be due to a primary cyst. In the other 3 cases the large cysts were so far in front that it was considered likely that they were the cause of the detachment (figs. 14, 18 and 19, cases 18, 23 and 25, respectively).

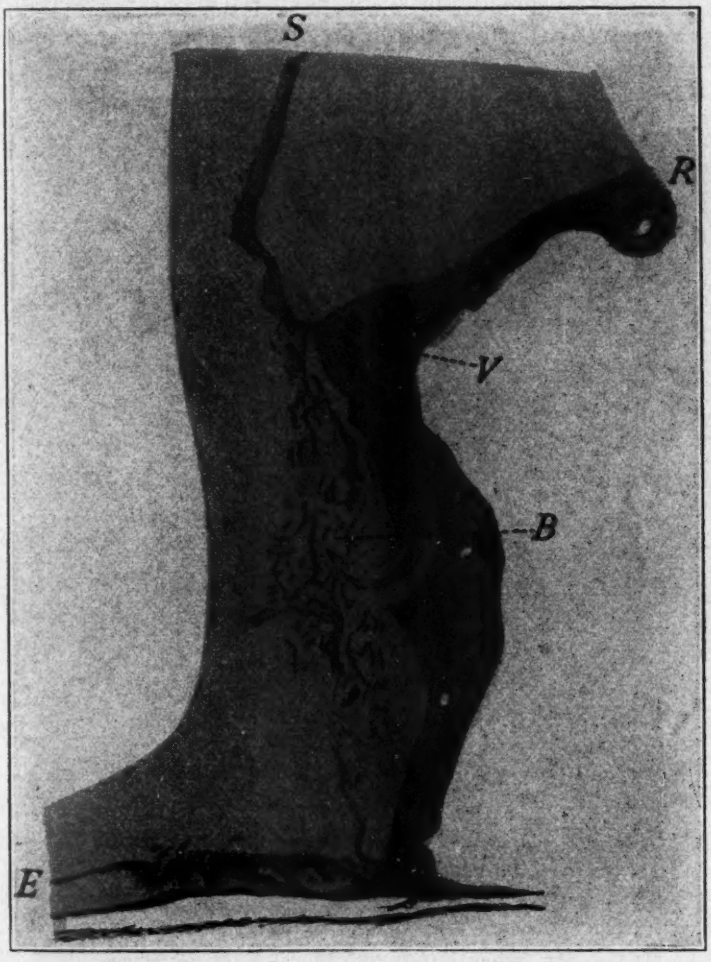


Fig. 20 (case 29).—Drawing of a section of an enucleated eye. Pointing to myopia was the great length of the globe and the absence of the choroid around the nerve head and, in its stead, an adhesion of the retina to the sclera. The retina is detached, and the vitreous has pulled on the retina just at the place where the base of the vitreous ends (*V*). The posterior surface (*S*) of the vitreous shows a condensed hyaloid membrane with a number of cells clinging to it. The base of the vitreous (*B*) as it lies on the retina contains many newly formed capillaries. The retina (*R*) is highly gliosed; the ciliary epithelium (*E*) is partly detached.

The large cyst in figure 14 was certainly a real cyst and not a pseudocyst. Its location at the posterior border of the tear, near the ora serrata, and on the temporal side where cysts are most often found reminded one of the cysts described by Weve. It is natural that the vitreous adheres here to the anterior lip of the laceration as it would be expected to do whenever the laceration is immediately behind the base of the vitreous. If the retina is bulged inward by an external cyst, it stands to reason that it would rupture more easily in front of the cyst

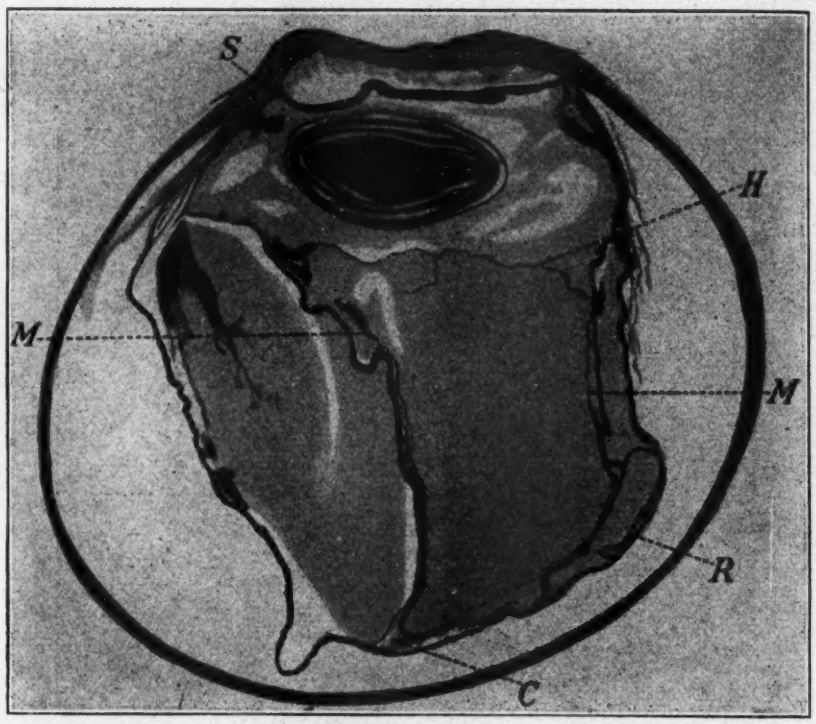


Fig. 21 (case 30).—Drawing of an enucleated eye, showing partial detachment of the retina and the condensed hyaloid membrane running across the eye (*H*). The retina is partly adherent to the choroid, and by traction cystic spaces (*C*) were formed. The traction caused splitting of the retina at (*R*). The exterior layers of the retina remain on the choroid, whereas the inner layers are detached. Fine membranes (*M*) on many places run parallel with the inner surface of the retina. Hemorrhages lie on the choroid and the retina. The iris shows a hump-shaped protrusion and a peripheral anterior synechia (*S*), pointing to glaucoma.

than behind it, because anteriorly it is thinner and more fragile. Moreover, the vessels which make up a greater part of the resistance of the retina are more brittle the farther forward they go.

A cyst at the equator is also likely to cause a tear, because it is in this region that the retina is already thin, as is the posterior limiting layer of the vitreous, which is here not so intimately connected with the retina as at the ora serrata. Undoubtedly the base of the vitreous and the thick posterior limiting layer springing from it reenforce the thin periphery of the retina. For this reason, in a zone 2 mm. wide and posterior to the base of the vitreous, the retina is usually spared lacerations.

*Stretching of the Retina.*—Stretching of the retina occurred in the 2 hydrophthalmic eyes, which was to be expected. In other cases in

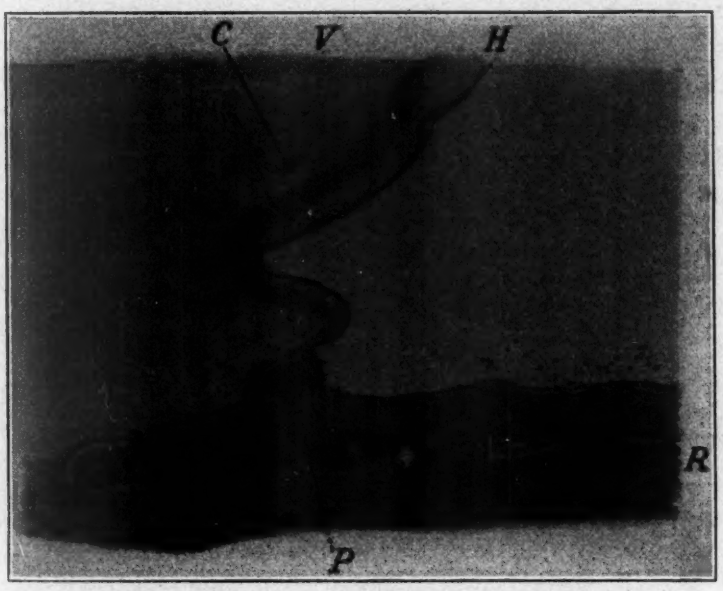


Fig. 22 (case 33).—Drawing of a section of the enucleated eye of a woman aged 73, which was blind for twenty-five years. Severe pain was present for several days, and there was injection of the ciliary arteries. The cornea was dull and the anterior chamber deep. There was hyphemia. Newly formed blood vessels were observed on the iris. Hyaline degeneration was present at the pupillary border. The lens was cataractous. Tension was + 2. Refraction of the fellow eye was —1.5 D. In this section the vitreous (*V*) is posteriorly detached. Its posterior surface forms an angle with the retina (*R*) and encloses a precipitate (*P*) formed by phagocytes and lymphocytes. The hyaloid membrane (*H*) is transformed into a dense membrane containing many cells. The retina (*R*) is highly degenerated and gliosed. In the vitreous the cross section of a newly formed capillary (*C*) is visible.

which there was a great increase in the subretinal fluid the retina was put on the stretch and distended forward, in some instances even pulling the ciliary epithelium away with it.

## SECONDARY ANATOMIC CHANGES IN THE RETINA AND OTHER TISSUES, CAUSED BY THE AGE OF THE DETACHMENT AND BY THE COMPLICATIONS OF INFLAMMATION AND GLAUCOMA

*Changes in the Retina.*—Degeneration and Atrophy of the Retina: A type of highly degenerated retina is shown in figure 1 (case 2). Cystic clefts and chalk deposits are shown in figure 7 (case 11). An eye in which only the inner nuclear layer persisted is illustrated in figure 8 (case 12). In only 3 of the 41 cases were remains of the ganglion cells identified. The degenerative sequence seemed to be disintegration, first, of the ganglion cells; second, of the outer nuclear layer, and third, of the inner nuclear layer. A final step was often a fusing of the two nuclear layers. Gliosis represented the highest degree of degeneration of the entire retina.

Changes in the Blood Vessels: The larger blood vessels were in general less affected than the smaller ones. The former were moderately

TABLE 4.—*Degenerative Changes in the Retina*

| Type of Degeneration | No. of Cases |
|---|---|
| Extensive degeneration | 19 |
| Atrophy | 12 |
| Relatively little degeneration | 7 |
| Inflammation | 2 |
| Partial necrosis | 1 |
| | 41 |

sclerosed in 18 cases, and in 8 cases few or no changes were found. Signs of perivasculitis were noticeable in 9 cases. In 4, the larger vessels were surprisingly few, seemingly having been obliterated without leaving traces. In 21 cases a majority of the small vessels were obliterated.

Folds: The histologic appearance of the retinal folds was different from that seen in cases of tumor and of endophthalmitis. In 12 cases numerous folds were seen, some of which were large. In 17 cases only a few folds were seen. In 5 cases there were none, owing perhaps to the fact that contracting membranes play a small role in cases of old spontaneous detachment. For this reason it was only in 4 cases that any great amount of connective tissue bound the folds together.

Changes in the Apertures: It has been known for a long time that retinal apertures may be sealed by a secondarily formed tissue. This is rarer in ruptures at the ora serrata than in those found elsewhere, probably because of their great extent. It is to be regretted that spontaneous healing does not occur earlier, reducing the occasion for operating. Of the five lacerations nearest the ora serrata, one was closed by vitreous and the others remained open. Of five other lacerations which were

situated at different points in the anterior half of the retina, one (fig. 24, case 36) remained entirely open. In figure 14 (case 18) the laceration was partly closed by a cyst and, moreover, blood lay nearby. The three other tears were closed partly either by neuroglia and blood or by a combination of both. In 2 cases (figs. 1 and 28, cases 2 and 41, respectively) the vitreous which bridged over the tear was lined by a

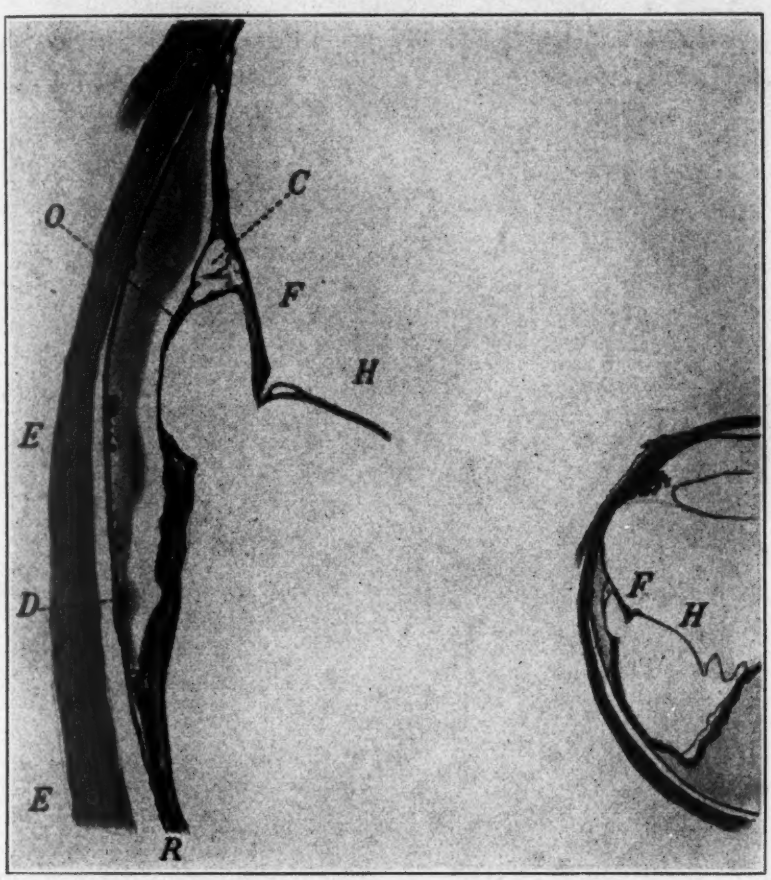


Fig. 23 (case 35).—Drawing of a section of the enucleated eye of a woman aged 83. Twenty years ago, and without pain, the eye became blind, probably from retinal detachment. Six weeks before there were headache and fever, followed by iritis, which may have been caused by metastasis from the fever or by toxins from the detached retina. The sketch to the right shows a part of the eyeball. Iris bombé is present. The retina is partly adherent and partly detached. The condensed hyaloid membrane (*H*) has torn out a flap of the retina (*F*). On the left a detail is drawn. The hyaloid membrane (*H*) has pulled and torn out a flap (*F*) of the retina, sparing the outer layers (*O*) and causing cystic spaces (*C*) at the root of the flap. The retina (*R*) is adherent to the choroid below. Drusen (*D*) of the lamina vitrea are abundant. The retina is highly degenerated. On the outside of the choroid frequent episcleritic foci (*E*) are recognized.

cellular layer on the retinal side. In both cases the tears were situated near the ora serrata, and in each instance the closure was a secondary one.

It is difficult to reach definite conclusions from cases of detachment of long standing, that in the first case being of twelve years' duration and that in the second case being of nineteen years' duration. Certainly such detachments speak against the Gonin theory that only the vitreous can lacerate the retina or extract pieces of it. Especially did the second case in question demonstrate that tears may happen without special

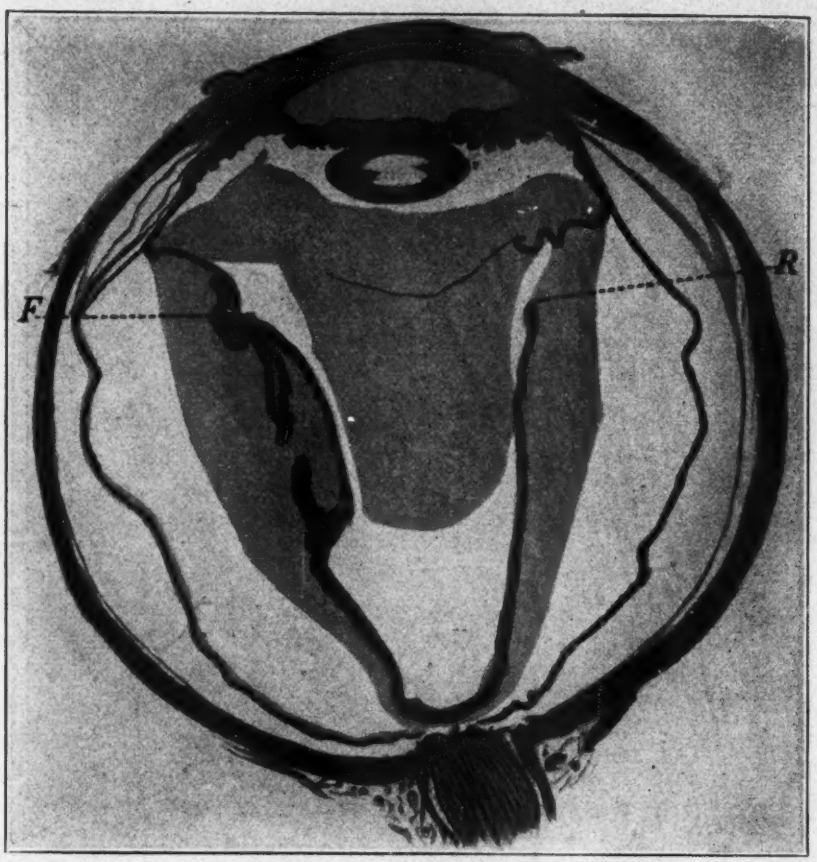


Fig. 24 (case 36).—Drawing of the enucleated eye of a man aged 73 in whom visual disturbance had been present for one year and pain and inflammation in the eye for two weeks. The anterior chamber was very deep, with a backward step in the iris. Rupture of the retina behind the ora serrata (*R*) and inversion of both lips are apparent. The posterior surface of the vitreous can hardly be seen because the hyaloid membrane is not conspicuous and the vitreous is only marked by a few cells lying in it. It runs from the anterior lip of the tear toward the folds of the opposite side (*F*). The anterior chamber is deep. The iris shows a step over the ciliary processes. There are a few lymphocytic foci in the choroid.

detachment of the vitreous and without pulling by it. In this case probably a "preretinitis" in the posterior part of the retina retracted the retina, so that it assumed the shape of a cone instead of conforming to that of the globe.

In connection with the closure of tears, it seems that in cases of retinal detachment of long standing the neuroglia tends to proliferate under the irritating influence of hemorrhages. That hemorrhages play a role as a factor in primary closure is likely, because hemorrhages are

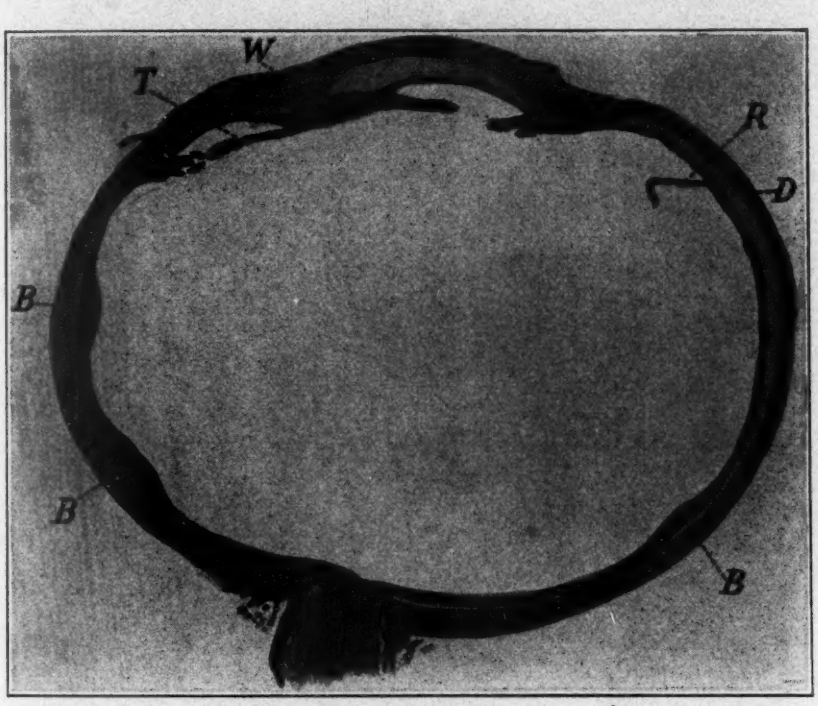


Fig. 25 (case 37).—Drawing of an enucleated eye which became blind six years before removal because of a contusion. Two weeks before, after a second contusion, severe inflammation set in. Blood and cholesterol crystals were present in the anterior chamber. An incised wound, filled with scar tissue (*W*), had perforated the cornea and lens, so that only a membranous traumatic cataract (*T*) remains. The iris protrudes. The ciliary processes are elongated and stretched due to shrinkage of the traumatic cataract. The choroid is detached (*D*), and the retina is torn away (*R*) from the ora serrata and hangs free like a flap. The retina is detached in many places, forming blebs (*B*). Surrounding the papilla the detachment is visible. Of the vitreous, almost nothing is to be seen.

so frequently found in the neighborhood of tears even in cases of long duration. Surely it would be hard to understand how neuroglia would

be able to span a defect in the retina were there not something else to bring about a preliminary closure.

Of the 3 cases in which holes were found, in 2 the hole remained open, whereas in the third case the hole was closed by a fibrous membrana limitans interna (fig. 29, case 17). In figure 3 (case 5), already referred to, a large open communication is apparent between the vitreous and the subretinal space.

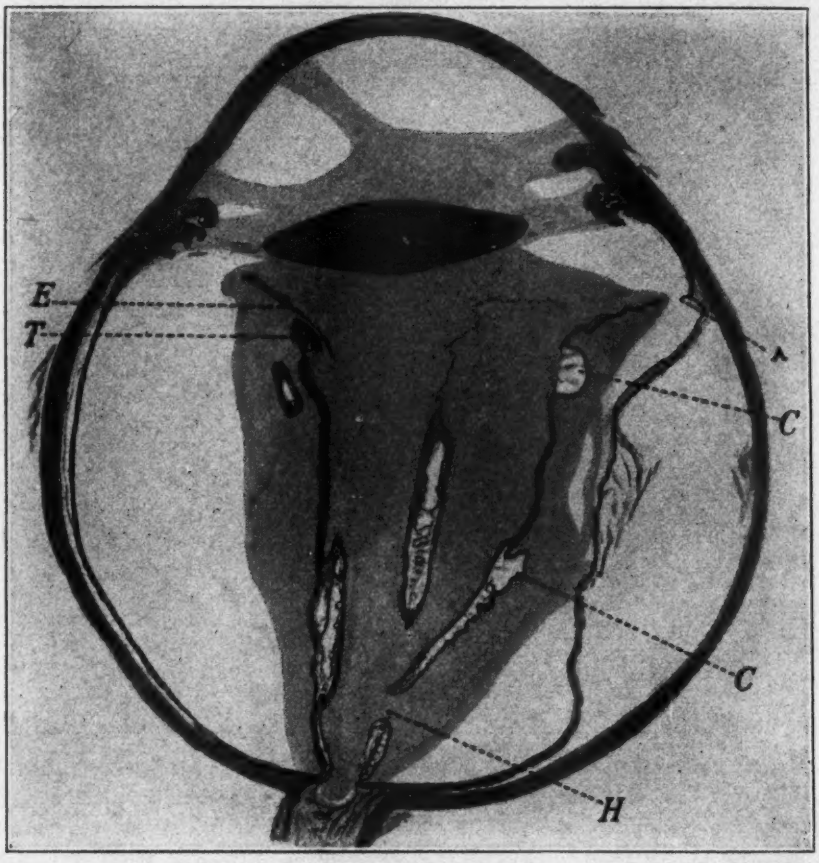


Fig. 26 (case 39).—Drawing of the enucleated eye of a man aged 22 with hydrophthalmos. Fourteen years before enucleation iridectomy with sclerotomy was done; a complicated cataract developed. Tension was + 2. Complete detachment occurred. To the right one can see that the retina with a piece of the ciliary epithelium is artificially torn away (*A*). On the left the retina is torn away from the ora serrata (*T*). The margin of the retina is turned inward. In front of it the vitreous has pulled the ciliary epithelium (*E*) inward. In the macular region a hole is visible (*H*). The retina shows excessive cystic degeneration and even cysts (*C*). The anterior chamber is very deep. The iris is retroflexed. The pupil is enormous. The papilla is totally excavated.

Splitting of the Retina: Bartels [6] has discussed splitting of the retina in relation to cysts. It may be said here in advance that not a single example of primary splitting of the retina was found in this material. In several instances there was a secondary splitting near the papilla. In myopic eyes, in the area of circumpapillary choroidal atrophy, the retina is usually adherent partly to the sclera and partly to the atrophic choroid. When, afterward, the retina becomes detached, the outer layers remain adherent but the inner layers yield to traction and are pulled away. Apparently no hole ever occurs in the immediate neighborhood of the papilla, probably because the inner layers of the retina here are too compact and resistant. In figure 8 (case 12) the retina is adherent on one

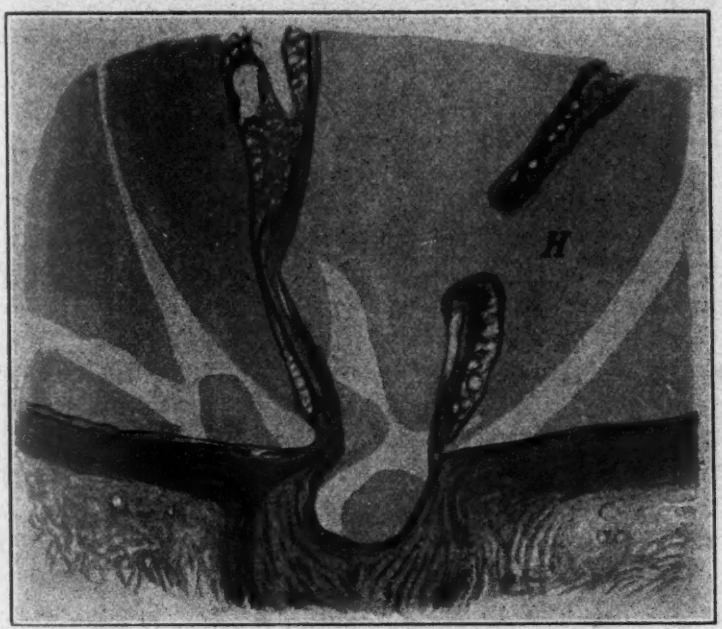


Fig. 27.—Drawing of a section of the eye shown in figure 26. The papilla is enormously excavated. The retina is detached. Cystic degeneration is present. In the macular region there is a hole (*H*) 0.6 mm. in diameter. The posterior lip is turned inward by a fine thin thread. The anterior lip is blunt. Cystic degeneration does not extend to the edges of the hole.

side of the papilla. In figure 29 (case 17) it is detached on both sides, but as a special symptom of inflammation due to traction, there is a small lymphocytic focus to the right at the border of the retinal synechia. In figure 18 (case 23) a piece of retina remained on the sclera, and the mechanism of splitting by the formation of cystic spaces is clearly demonstrated. An unusually extensive division of the retina into two layers

6. Bartels, M.: Netzhautspaltung, Netzhautrisse, Netzhautablösung, Klin. Monatsbl. f. Augenh. **96**:1, 1936.

by the traction of fine membranes on its inner surface is brought out in figure 21 (case 30). The pulling had caused cystic spaces to develop, the separating walls of which later disappeared, allowing the inner layers to be drawn away, leaving large pieces of retinal tissue adherent to the choroid.

*Changes in the Vitreous.*—Owing to the prominence given to the Gonin-Lindner theory that traction exerted by the vitreous is responsible for a majority of retinal detachments, special attention was paid to the study of the vitreous body and particularly to the state of its posterior limiting layer. The principal problem was to decide whether the membrane that is so often found on the posterior limiting layer of vitreous develops before or after the onset of the detachment of the vitreous.

In some cases of detachment of the vitreous only a few cells were found on the posterior surface of the limiting layer (fig. 4, case 8), whereas in other cases (figs. 20 and 22, cases 29 and 35, respectively) a thick layer of oblong cells was present, giving the impression of connective tissue cells. One would have been inclined to believe that the detachment of the vitreous had been due to a shrinkage of this fibrous membrane, but the fact that this tissue was thrown into many folds seemed to show that the detachment of the vitreous was caused by its own shrinkage. It was believed that the cellular coating represented a layer developed from cells which, after the detachment of the vitreous had taken place, spread out on its posterior surface. In some cases the presence of only a few isolated cells on the posterior surface of the vitreous pointed to this.

In reality, the normal posterior limiting layer (hyaloid membrane) of the vitreous is the dense compact terminal substance of the stroma of the vitreous body and normally contains no cells. Any coating of cells found over it is to be considered a pathologic formation. One concludes from cases of spontaneous detachment of the vitreous, as in figures 1 and 2 (case 2), that apparently cells originating in the retina may float in the preretinal fluid and land on the surface of the vitreous and proliferate there. It is likely that from such cells at first a mere coating develops and later a layer of fibrous tissue.

Nature of the Tissue on the Posterior Surface of the Vitreous: The question arises as to whether the cells of the layer in figure 2 are derived from the neuroglia cells of the retina or from the epithelial cells of the ciliary body. Between the vitreous body and the cellular membrane there lies a homogeneous membrane. The cells lying on this membrane are too regular for glial cells. In favor of an epithelial origin is the regular oblong shape of the nuclei, suggestive of epithelial cells derived from the ciliary epithelium, with which they are continuous at the ora serrata, a point in favor of their origin from the ciliary epithelium. After all, there may be no essential difference between proliferated neu-

roglia and proliferated ciliary epithelium, as both originate from the inner sheath of the secondary optic vesicle and are related. It is understandable that the proliferated product of the two may look alike.

In figures 15, 16 and 17 (case 20) an especially thick membrane covers the hyaloid membrane. It is plainly seen that the hyaloid membrane in many places is covered by a regular layer of cells having large protoplasm and lying in a row like epithelium or endothelium. The nuclei are all blunt and oblong. They are of different sizes, some being small, some large and some even gigantic. From these particular cellular characteristics a neuroglial origin of this layer becomes evident.

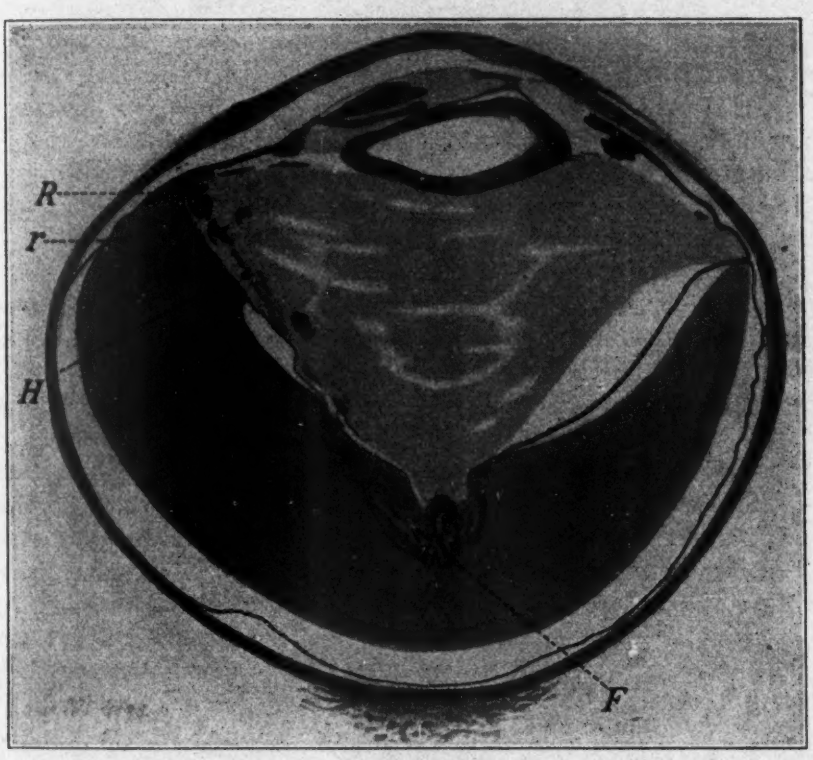


Fig. 28 (case 41).—Drawing of the enucleated eye of a man aged 37, who nineteen years previously had acute blennorrhea with a perforating ulcer followed by secondary glaucoma. Complete detachment of the retina is seen. Posteriorly the retina is glued together in a conglomeration of folds (*F*). To the left the retina is detached, dragging with it a stretch of the ciliary epithelium. Small pieces of retinal tissue are left at *R* and *r*. The hole (*H*) is closed by a thin cellular membrane which lies on the posterior limiting layer of the vitreous (hyaloid membrane). The membrane proceeds backward and disappears. Still farther posteriorly where the vitreous is in touch with the retina are islands of the membrana limitans interna of the retina. From the mass of folds posteriorly the retina runs direct to the ora serrata, as if on the stretch. The anterior lip of the tear shows the effect of traction by the tearing away of the ciliary epithelium.

Connective tissue cells never have such bluntly edged nuclei and never differ so much in size. It is known that neuroglia cells can proliferate and also that they are able to wander. The character of this membrane as being formed by neuroglia is supported by the presence of cysts (fig. 15, case 6) which are similar to the type found in retinal tissue.

In figure 4 (case 8) the shrunken vitreous is shown lying behind the lens. The space between the detached vitreous and the bulging retina is filled with a coagulated albuminous fluid. Near the ora serrata a laminated membrane situated some distance in front of the retina divides into two leaves. The anterior, which is apparently the hyaloid membrane, runs toward the posterior pole of the lens, while the posterior leaf continues over the retinal surface, representing the membrana limitans interna. It lines the entire surface of the funnel-shaped retina. In this case it is clearly visible that the membrane on the posterior surface of the shrunken vitreous is not a hyaloid membrane alone but also contains the membrana limitans interna of the retina. The latter is easily detached from the retina by edema, and minute folds in it are well known from examination with the red-free lamp.

In a microscopic examination of the finer structures of an old retinal detachment it is often difficult to decide what has happened to the membrana limitans interna. Apparently it may be changed and may even disappear without a trace. The inner surface of a degenerated retina is frequently rough and frayed, causing one to believe that the membrana limitans interna is separated. In other cases, however, one gets the impression that the membrana limitans interna and the hyaloid membrane by fusing form a homogenous layer, sometimes sparsely cellular, which by some authors is called "hyaloid membrane," which in reality it is not.

Significance of Neuroglia in the Formation of the Membrane Behind the Vitreous: In posterior detachment of the vitreous it is almost a rule that starting at the point of separation from the retina a cellular layer spreads over the hyaloid membrane. It is likely that in cases of long-standing detachment the peripheral area of the retina is stimulated to produce this cellular layer by traction on the part of the detached vitreous. If the layer were composed of connective tissue, it would be able to heal a tear by contraction, but the retina has not the power to produce connective tissue, not even from the walls of the vessel, as seen clinically in a retina showing holes bridged over by vessels. Membranes on the retina, as in cases of retinitis proliferans or in atrophic globes, are the product of organized exudate. In some instances of posterior detachment the vitreous detaches and goes off with the hyaloid membrane, as in figure 4, and the corresponding surface of the retina presents a naked, ragged appearance. Under these circumstances the hyaloid membrane and the membrana limitans interna may be fused into one layer which may be lined by cells.

Opacities of the Vitreous: In cases of high myopia one expects to find clinically many opacities of the vitreous at a certain age. The layer of cells just discussed, when the vitreous is detached, is to be faintly seen with the ophthalmoscope, but the usual floating opacities observed clini-

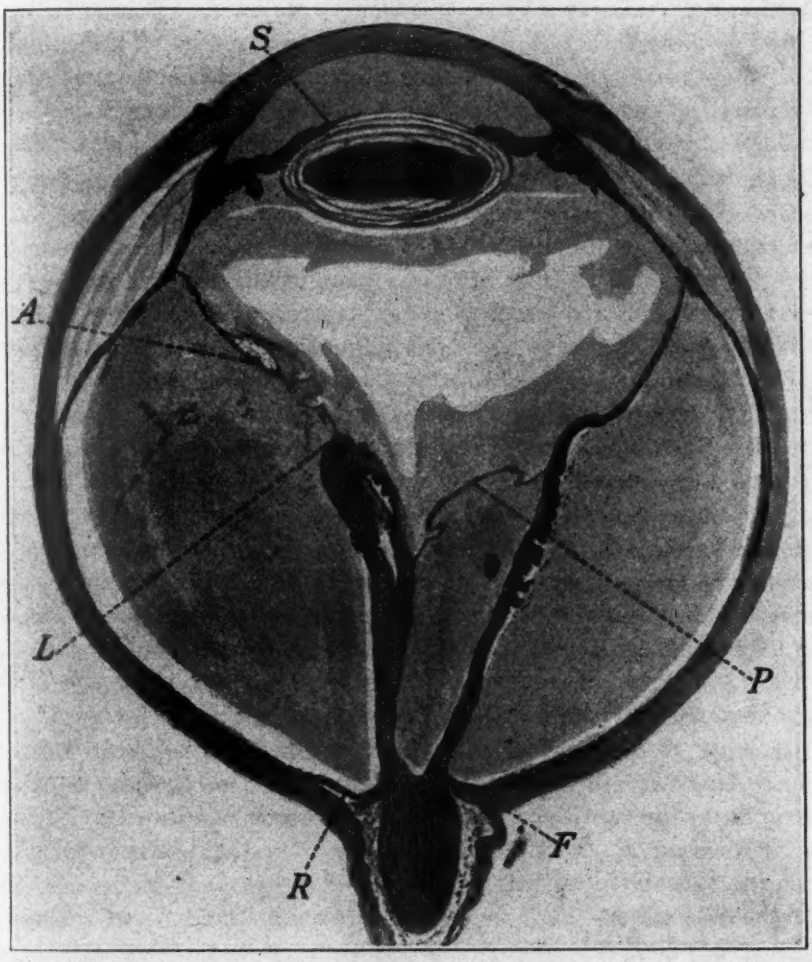


Fig. 29 (case 17).—Drawing of the enucleated eye of a woman aged 61, in whom detachment of the retina developed one year before enucleation. Eight days before, inflammation and pain set in; the tension was reduced. Complete detachment of the retina is visible. The posterior detachment of the vitreous (*P*) is in no relation to the retinal tear on the left side. The posterior lip (*L*) of the tear is blunt and is formed by conglomerated folds. The anterior lip (*A*) is thin and shows cystic degeneration. The hole is closed by a condensed hyaloid membrane, which is attached to both lips. The retina on both sides is adherent to the papilla, and pieces of it remain on the sclera (*R*) near the ora serrata on the left. Lymphocytic foci (*F*) are visible. The pupillary border of the iris is free on the right side and adherent on the left side.

cally within the vitreous body are not discernible under the microscope. For instance, many corneal opacities visible in life are made out in slides with difficulty, because they are due to an irregular distribution of fluid in and between the corneal lamellae or to a different colloidal constitution in places, all of which does not show at all or very little in the fixed preparation. Probably similar conditions occur in the vitreous, as many of the threadlike opacities seen in life are not caused by an accumulation of cells or threads of tissue but are expressions of changes in colloidal makeup. In 1 case the vitreous lay on the retina posteriorly, as if retracted, forming an unusual picture and showing a great deal of dark pigment.

*Changes in the Ciliary Body.*—The ciliary body usually showed signs of inflammation, as it does in cases of severe lesions that lead to enucleation. However, heavy infiltrations of lymphocytic foci and plasma cells were found in only 3 cases, whereas in 9 there was the slightest reaction. In 5 cases the ciliary body was lined by membranes, which looked different from membranes seen in cases of septic endophthalmitis. They were looser and more vascular and were more in relation to the base of the vitreous. Such a membrane is shown in figure 6 (case 11) in which the vitreous is enclosed between the membrane and the retina.

In 9 cases the ciliary body was extremely atrophic. The atrophy probably was caused more by increase of tension than by inflammation. The high degree of atrophy often seen indicated that the increase of tension had been present much longer than the history led one to suspect. In a large number of cases the ciliary epithelium was detached from the flat part, sometimes in vesicles, as in figure 6, but more frequently it was continuous with detachment of the retina (fig. 4, left side, case 8).

In some cases in which the ciliary epithelium had been dragged away a *Ringschwiele* developed as an expression of reaction to toxins coming from the subretinal sac. A *Ringschwiele* is formed by the pigment epithelium, and it is therefore a type of epithelial tissue, produced under the stimulus of toxins.

It seemed strange that the ciliary epithelium could be so frequently detached and to such an extent, sometimes even as far as to the corona ciliaris. The detached epithelium looked thin and friable, especially since the cylindric cells of the epithelium have a direction perpendicular to the surface. One was astonished that this layer was not more frequently lacerated instead of being detached intact. The cells may possess a special power of coalescence, originating as they do embryologically from the inner leaf of the secondary optic vessels and representing the retina on the ciliary body.

*Changes in the Iris.*—The iris was, as a rule, infiltrated, and in 13 cases a marked attenuation of the stroma was noted. In 11 cases such marked signs of long-standing inflammation were present as synechiae,

lymphocytic nodules, pupillary membranes and newly formed vessels on the anterior surface. It was especially interesting that in 10 cases, that is in about 25 per cent of the material, iris bombé was observed. Iris bombé is rare in cases of endophthalmitis because the toxins from an abscess of the vitreous irritating the iris from behind cause a total posterior synechia and in this way hinder any bulging forward. Thus a tumor in a state of necrosis practically never produces iris bombé, but instead complete detachment. Iris bombé may be considered as a sign of old detachment if the history makes it clear that the eye was blind beforehand.

*Changes in the Lens.*—In 19 cases a complicated cataract was present. In 2 cases a pyramidal cataract was found. In 1 case an entirely liquefied lens, presenting no sign of a nucleus, showed a single layer of epithelium extending around its entire capsule, an unusual finding, because as a rule in cases of complicated cataract the epithelium is confined only to the anterior part of the lens. Throughout the survey one had the impression that detachment of the retina has a specially deleterious influence on the capsular epithelium and quickly produces a cataract. In 3 cases of recent detachment the lens was transparent.

*Hemorrhages in Various Parts.*—Hemorrhages were encountered in all but 18 cases. Blood was generally abundant and was found in all possible places, even detaching the ciliary body. In 11, it lay on the inner surface of the retina and in 9 on its outer surface. There was a remarkably large amount of blood in the vitreous in 3 cases. There was hyphemia in the anterior chamber in 2 cases. In 4, the ciliary body was covered with blood.

At first one was inclined to assign to the hemorrhage the final irritation and onset of pain which led to enucleation. However, the fact that no hemorrhage was seen in 18 cases and that the hemorrhage when found appeared recent made it more likely that it was a secondary occurrence rather than an etiologic factor. Hemorrhage was taken to be a manifestation of an abnormal condition of the walls of the vessels. Newly formed membranes on the surface of the iris and the atrophic condition of the anterior part of the uvea suggested that blood could readily escape from these sources. As nearly all the iritic changes appeared to be old whereas the hemorrhages were fresh, much of the blame for the latter was laid on glaucoma, which only too frequently is accompanied by hemorrhages, especially when the blood vessels are already brittle.

*Changes in the Choroid.*—In 9 cases the choroid was found to be normal. In 12, lymphocytic foci were found. This is not astonishing when in so many cases inflammation led to the enucleation. In 10 cases the choroid was detached together with the ciliary body, although in 3 of these cases the tension was high. One is accustomed to find detachment

of the choroid in soft eyes. In 5 cases the choroid was ruffled but was not detached, and in only 1 of these 5 cases was the tension decidedly soft at the time of enucleation. It may be that globes with choroidal detachment or ruffling, which are hard at the time of enucleation, have a period of hypotension during which detachment or ruffling takes place. Finally, as a result of inflammation, they become glaucomatous.

Direct Reaction of Retinal Detachment on the Choroid: Two types of direct reaction from detachment of the retina were observed in the choroid. First, irritation exerted by toxins from the subretinal fluid on the pigment epithelium was obvious, often causing the cells to proliferate. Five times a large number of drusen were present. They contained no connective tissue or chalk and were small and hyalinized and especially close to the papilla. Second, a reaction in the stroma of the choroid took place in spots where there was special traction by the detached retina, similar to that occurring in atrophic eyes. Traction on the choroid in eyes in which the retina is detached by pulling membranes is much stronger than traction in spontaneous retinal detachment. In this material strong traction happened only when the subretinal fluid was under great pressure, causing the retina to be spanned out tautly. In 2 instances of extraordinary traction at the ora serrata there were bone formation and chalk. In another case, which was placed in the group of cases of recent detachment, a piece of retina adhered to the choroid even after complete detachment, showing that there had been an inflammatory reaction.

Almost every retinal synechia at the beginning is characterized by an intense lymphocytic infiltration in the underlying choroid. In this way an adhesion between the two tissues is brought about. Later, after a period of quiescence, a fresh irritation and infiltration may be set up by traction from the retina on the adhesion. There was strong traction in 1 case, which was diagnosed by the shape of the retinal adhesion which contained a large cyst in which cholesterol crystals and phagocytes with blood pigment were enclosed. Effects of strong traction are shown in figure 18 (case 23).

*Changes in the Papilla.*—Usually the atrophic papilla was hidden behind the retina, when the detachment was total. In the globes in which the tension had been high either the compressed and folded retina filled the excavation (figs. 4 and 8, cases 8 and 12, respectively) or the excavation was entirely free of tissue (fig. 11, case 14). In the first group the retina was pushed into the choroidal canal apparently by an increase of pressure in the subretinal sac, driving it to the median line. The wide and naked glaucomatous excavation of the second group seemed to be the result of several factors. First, not only did the lamina cribrosa become ectatic in the glaucomatous myopic globes but also the neighboring scleral covering of the intervaginal space of the optic nerve, which is

usually wide in cases of myopia. Second, in the circumpapillary area of the highly myopic globes adhesions of the retina to the choroid and sclera were common. Under these conditions, when a detachment started the adherent retina was not to be separated from the choroid or sclera in this zone and was prevented from being pushed into the papilla. Third, the great expanse in which a circumpapillary synechia of the retina was sometimes split indicated that the traction necessary to produce this could have been exerted only by pressure coming from the subretinal space.

An interesting change is seen at the papilla in figure 13 (case 16). The retina was entirely detached. A reddish stained hyaline mass covered by epithelium lay on the lamina vitrea. It was certainly an epithelial connective tissue, having great similarity to a *Ringschwiele,* which in this case was also present on the flat part of the ciliary body where a detachment of the nonpigmented ciliary epithelium had taken place. This is the only tissue of its kind at the papilla I ever remember having seen.

*Tension.*—In 26 cases, representing a majority, the tension was elevated, being high in most of them. In 1 case normal tension was reported, and in 4 the eye was soft. Many different signs of glaucoma were observed. As mentioned previously, iris bombé occurred in about one fourth of the cases. One was inclined to believe that the glaucoma was secondary to iritis and was produced in a round about way by iris bombé or a peripheral synechia.

It is possible that there was another factor at work in the origin of the secondary glaucoma. In the beginning, detachment of the retina is frequently combined with low tension, so that the retina falls inward and is not pushed inward. On the contrary, in cases of long-standing detachment combined with secondary glaucoma there always seemed to be a subretinal increase of tension. That a *Ringschwiele* on the flat part of the ciliary body and splitting of the retina at the papilla were so often present was taken to mean that the tension in the subretinal space was higher than that in other parts of the globe. It is possible that glaucoma in eyes with an old detachment sometimes originates in an increase of the subretinal fluid. An example of this kind is shown in figure 5 (case 9), in which a distended vesicle stood under pressure, the fluid within it being more albuminous than that in other parts of the detachment. Its steep margin indicated that it had exerted traction. The conclusion was reached in at least 10 cases that subretinal congestion of fluid had been at the bottom of the glaucoma, judging by the balloon-shaped bulging forward of the retina. The 10 cases of subretinal glaucoma correspond almost exactly with the 11 cases in which *Ringschwiele* were found. That the subretinal fluid is the cause of severe inflammation in cases of long-standing detachment has always been

emphasized by Meller, who advised scleral paracentesis, after which the iritis and glaucoma as a rule quiet down.

As an example of another cause of glaucoma, reference is made to the specimen shown in figure 4 (case 8), in which huge primary cysts were assumed to have bulged forward the retina. As such cysts are the result of a primary accumulation of fluid, they were considered to be a possible cause of glaucoma.

*Inflammation of the Uvea.*—Notwithstanding the fact that severe iritis, frequently combined with iris bombé and glaucoma, was given as the reason for most enucleations, a clear conception of the etiology of the inflammation was not arrived at in this study. It was difficult to understand why inflammation may come on so many years after the beginning of a retinal detachment, even as long as twenty years. It would not be impossible for focal infection to play a certain role in setting up inflammation in ocular tissues in which the normal metabolism had been greatly disturbed. When blood vessels are in poor condition and when regressive metamorphoses are going on, it would not seem strange to argue that germs or toxins which are innocuous in ordinary healthy tissues may suddenly cause irritation in a diseased globe. It is certain that the subretinal fluid has an irritating effect, judging by what has been seen to be the behavior of the pigment epithelium in cases of retinal detachment of long standing. An albuminous fluid retained in a cavity over a long period in all probability changes its quality and becomes irritating to neighboring tissues, just as gallstones may remain for years without giving trouble until finally they lead to cholecystitis. It must be stressed that the fluid referred to is the congested fluid of old detachments and is not the primary fluid of recent detachments with a hole or laceration, which certainly originates from the vitreous. The fluid of a recent retinal detachment without an aperture probably comes from the retina.

# NUTRITIONAL CATARACT AND RELATION OF GALACTOSE TO APPEARANCE OF SENILE SUTURE LINE IN RATS

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Production of cataract in albino rats placed on a diet deficient in riboflavin (vitamin G, or $B_2$) was first reported by Day, Langston and O'Brien [1] in 1931. Confirmation of these results has been obtained by O'Brien [2] and Yudkin.[3] Langston, Day and Cosgrove [4] were able to produce this form of cataract in albino mice, and Langston and Day,[5] in Norway rats. Langston and Day [6] found that development of cataract in albino rats was arrested when vitamin G was supplied in the form of skim milk powder. The diet used by these investigators in this work on cataract was the "vitamin B-complex deficient diet" of Sherman and Spohn,[7] modified by incorporating an 80 per cent alcoholic extract of rice polish.[1] The incidence of cataract was consistently close to 100 per cent, the average time of appearance of the cataract being about ten

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2. O'Brien, C. S.: Experimental Cataract in Vitamin G Deficiency, Arch. Ophth. **8**:880 (Dec.) 1932.

3. Yudkin, A. M.: Ocular Disturbances Produced in Experimental Animals by Dietary Changes: Clinical Implications, J. A. M. A. **101**:921 (Sept. 16) 1933.

4. Langston, W. C.; Day, P. L., and Cosgrove, K. W.: Cataract in the Albino Mouse Resulting from a Deficiency of Vitamin G ($B_2$), Arch. Ophth. **10**:508 (Oct.) 1933.

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weeks.[8] More recently evidence has been presented by Day, Darby and Langston [9] and by Day, Darby and Cosgrove [10] to show that riboflavin [11] is identical with the cataract-preventive factor, since supplementing the diet of Sherman and Spohn with riboflavin prevented the appearance of cataract and injection of riboflavin arrested the development of cataract.

Bourne and Pyke,[12] however, fed this diet to rats which were heavier initially than those used by Day and his associates and were able to obtain an incidence of cataract amounting to only from 20 to 31 per cent. Bourne [13] has stated that of 98 rats observed by her on this diet only 15 exhibited cataract. György,[14] working with synthetic diets supplemented with crystalline vitamin $B_1$ and preparations of yeast which were devoid of riboflavin, observed no cataract in over 500 rats.[14a] Sen, Das and Guha [15] reported only 5 cases of cataract in 41 rats on a diet deficient in vitamin $B_2$, while Jansen [16] observed no cataract in animals fed diets deficient in certain fractions of the water-soluble vitamins, although other symptoms of vitamin G deficiency were manifested. Kellogg [17] was able to obtain cataract in only from 60 to 71 per cent of rats fed a diet deficient in vitamin $B_2$.

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8. Day, P. L., and Langston, W. C.: Further Experiments with Cataract in Albino Rats Resulting from the Withdrawal of Vitamin G ($B_2$) from the Diet, J. Nutrition **7**:97, 1934.

9. Day, P. L.; Darby, W. J., and Langston, W. C.: The Identity of Flavin with the Cataract-Preventive Factor, J. Nutrition **13**:389, 1937.

10. Day, P. L.; Darby, W. J., and Cosgrove, K. W.: The Arrest of Nutritional Cataract by the Use of Riboflavin, J. Nutrition **15**:83, 1938.

11. Riboflavin is the name given to the product described as "6,7-dimethyl-9-d,l'-ribityl-isoalloxazin" in conformity with the terminology accepted by the Council on Pharmacy and Chemistry of the American Medical Association (J. A. M. A. **108**:1340 [April 17] 1937).

12. Bourne, M. C., and Pyke, M. A.: The Occurrence of Cataract in Rats Fed on Diets Deficient in Vitamin $B_2$, Biochem. J. **29**:1865, 1935.

13. Bourne, M. C.: Metabolic Factors in Cataract Production, Physiol. Rev. **17**:1, 1937.

14. György, P.: Investigations on the Vitamin $B_2$ Complex: I. The Differentiation of Lactoflavin and the "Rat Antipellagra" Factor, Biochem. J. **29**:741, 1935.

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15. Sen, K.; Das, N., and Guha, B. C.: Pathological Changes in the Eye in Experimental Vitamin $B_2$ Deficiency, Science & Cult. **1**:59, 1935; abstracted, Chem. Abstr. **29**:7400, 1935.

16. Jansen, B. C. P.: Cataract-Producing Diets, Acta brev. Neerland. **5**:165, 1935.

17. Kellogg, M.: Appearance of Cataract in Rats on a Vitamin $B_2$-Low Diet, Proc. South Dakota Acad. Sc. **17**:21, 1937.

These varying results from different laboratories have not been satisfactorily explained. They may be due to differences in the source of the water-soluble B vitamins other than riboflavin. In order to eliminate these variables in the diet, our original purpose was to duplicate the diet used by Day and his co-workers, and Dr. Day obligingly supplied us with liberal quantities of the 80 per cent alcoholic extract of rice polishings evaporated down on corn starch, as a source of the B vitamins. For comparative purposes we wished also to produce cataract by inclusion of a large amount of lactose in an otherwise sufficient diet. This type of cataract was first reported by Mitchell and Dodge,[18] and subsequent work by Mitchell [19] and Yudkin and Arnold [20] has shown that it is due to the galactose portion of the lactose molecule. Day,[21] Bellows [22] and Morgan and Cook [23] had no difficulty in obtaining cataracts in rats placed on diets which contained large amounts of lactose.

## EXPERIMENTS

With minor modifications, two types of diet were used. They were of the following composition:

| | Diet 1 % | Diet 2 % |
|---|---|---|
| Casein | 18 | 15 |
| Corn starch | 48 | .. |
| Lactose | .. | 70 |
| Salt mixture | 4 | 5 |
| Butterfat | 8 | 9 |
| Cod liver oil | 2 | 2 |
| Rice polish extract evaporated on corn starch [24] | 20 | .. |

Diet 2 was supplemented with 0.5 Gm. of yeast per rat per day, six times a week. The animals used were white albino rats.

The details of the diet and the number of rats used in the experiments may be tabulated as follows:

18. Mitchell, H. S., and Dodge, W. M.: Cataract in Rats Fed on High Lactose Rations, J. Nutrition **9**:37, 1935.

19. Mitchell, H. S.: Cataract in Rats Fed on Galactose, J. Nutrition (supp.) **9**:14, 1935.

20. Yudkin, A. M., and Arnold, C. H.: Cataract Formation in Rats Fed on a Diet Containing Galactose, Proc. Soc. Exper. Biol. & Med. **32**:836, 1935.

21. Day, P. L.: Blood Sugar in Rats Rendered Cataractous by Dietary Procedures, J. Nutrition **12**:395, 1936.

22. Bellows, J. G.: Biochemistry of the Lens: IX. Influence of Vitamin C and Sulfhydryls on the Production of Galactose Cataract, Arch. Ophth. **16**:762 (Nov.) 1936.

23. Morgan, A. F., and Cook, B. B.: Cataract- and Dermatitis-Producing Nutritional Factors, Proc. Soc. Exper. Biol. & Med. **34**:281, 1936.

24. Supplied by Dr. P. L. Day.

Experiment 1, diet 1 (Day)..... 10 rats.
First five weeks, S. M. A. casein[25] and McCollum's salt mixture 185.[26]
Beginning the sixth week, Labco casein[27] and Osborne and Mendel's salt mixture.[28]

Experiment 2, diet 1 (Day)..... 13 rats.
Labco casein throughout experiment..... 8 rats.
S. M. A. casein throughout experiment..... 5 rats.
Osborne and Mendel's salt mixture throughout experiment 13 rats.

Experiment 2, diet 1 supplemented with 20 micrograms of natural riboflavin six times a week....4 rats.

Experiment 2, diet 2 (70 per cent lactose).... 6 rats.
Labco casein throughout experiment..... 2 rats.
S. M. A. casein throughout experiment..... 4 rats.
Osborne and Mendel's salt mixture throughout experiment 6 rats.

In both experiments the rats were placed in individual cages with raised floors made of wire screen. The floors of the cages were cleaned, and all rats were weighed once a week. Tap water was given as desired. Postmortem examinations were made as soon as possible after death, and when significant changes in the internal organs were found, these organs were saved for subsequent histologic examination. The examinations have not yet been made.

## RESULTS OF EXPERIMENTS WITH DIET 1

Cataract developed in 2 of the 23 rats placed on diet 1 unsupplemented (rats 9507 and 10262). One of these rats was from the group used for experiment 1 and the other was from the group used for that part of experiment 2 in which S. M. A. casein was used in the basal diet throughout the experiment. The remaining 21 rats on diet 1 were free from cataract until death.

All 23 rats showed an initial increase in weight at the end of the first week, which was followed generally by a decline thereafter. The average response in weight of the 5 rats on diet 1 in which S. M. A. casein was used throughout was slightly, but not significantly, smaller than that of the 8 rats on diet 1 in which Labco casein was used throughout.

In the first experiment all but 1 of the animals survived beyond the average time for the appearance of cataract as reported by Day and his associates, yet cataract occurred in that time in only 1 rat. In the second experiment, however, only 2 of the animals survived beyond the average time for the appearance of cataract, and in 1 of these cataract did occur. It is thus possible that had the animals used for the second experiment survived for a longer time more cataracts might have developed, although this is not indicated by the first experiment. The difference in survival time in the two experiments is interesting to note but difficult to explain.

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25. Supplied by the S. M. A. Corporation. This casein will subsequently be designated S. M. A. casein.

26. McCollum, E. V., and Simmonds, N.: A Study of the Dietary Essential, Water-Soluble B, in Relation to Its Solubility and Stability Towards Reagents, J. Biol. Chem. **33**:55, 1918.

27. A commercial brand of casein sold by the Casein Company of America, Inc.

28. Osborne, T. B., and Mendel, L. B.: The Nutritive Value of the Wheat Kernel and Its Milling Products, J. Biol. Chem. **37**:557, 1919.

Alopecia appeared in many of the animals, beginning around the genitalia and spreading over the body. Alopecia of the lids was a frequent observation; coincident with it, there was a profuse sanguineous discharge from the eyes.

All 4 of the rats placed originally on diet 1 supplemented with 20 micrograms of natural riboflavin six times a week showed a normal response in growth, the fur was in excellent condition and no lenticular or corneal changes were observed. After five weeks 0.5 Gm. of yeast was substituted for the riboflavin supplement in the diet of 2 of these 4 animals, with no significant effect except a slight stimulus to growth.

*Weight Response, Survival Time and Time of Appearance of Cataract in 23 Rats on Diet 1 Unsupplemented*

| Rat No. | Initial Weight, Gm. | Final Weight, Gm. | Survival Time, Days | Time of Appearance of Cataract, Days | Comment |
|---|---|---|---|---|---|
| Experiment 1 | | | | | |
| 9477 | 34 | 22 | 62 | .. | Died from pneumonia |
| 9488 | 35 | 38 | 105 | .. | |
| 9496 | 34 | 46 | 166 | .. | Killed on 166th day |
| 9500 | 32 | 30 | 130 | .. | Died from pneumonia; yellow streaked liver |
| 9502 | 33 | 28 | 76 | .. | |
| 9505 | 33 | 44 | 107 | .. | Yellow liver |
| 9507 | 32 | 55 | 141 | 89 | Weighed 44 Gm. when cataract appeared; reached a weight of 89 Gm. on 118th day; died from pneumonia |
| 9514 | 32 | 39 | 112 | .. | Yellow liver |
| 9517 | 33 | 38 | 107 | .. | Died from pneumonia |
| 9518 | 33 | 47 | 112 | .. | Yellow liver |
| Experiment 2 | | | | | |
| 10237 | 33 | 32 | 28 | .. | Yellow liver |
| 10238 | 35 | 48 | 54 | .. | Yellow liver |
| 10239 | 34 | 50 | 87 | .. | Changed to 20 per cent lactose diet on 87th day |
| 10240 | 35 | 48 | 25 | .. | Yellow liver |
| 10243 | 32 | 41 | 28 | .. | Yellow liver |
| 10244 | 33 | 32 | 59 | .. | Yellow liver |
| 10255 | 30 | 31 | 56 | .. | Yellow liver; died from pneumonia |
| 10256 | 26 | 31 | 57 | .. | Yellow liver |
| 10257 | 29 | 26 | 58 | .. | Killed for enucleation of eyeball |
| 10258 | 33 | 35 | 39 | .. | Yellow liver |
| 10261 | 33 | 37 | 58 | .. | Killed for enucleation of eyeballs |
| 10262 | 31 | 142 | 102 | 31 | Weighed 35 Gm. when cataract developed; killed in good health on 102d day |
| 10263 | 33 | 36 | 49 | .. | Yellow liver |

*Ocular Changes in Rats on Diet 1 (Riboflavin Deficient).*—The lens, like embryonic tissue, is transparent and under favorable conditions remains so.

The normal human lens at birth and from our observations the normal lens of the rat at 3 weeks of age have a well defined fetal nucleus demarcated by evident suture lines, the fetal Y sutures (fig. 1).[29] The anterior Y is erect, and the posterior Y is inverted. These suture lines represent the junction of lens fibers from the three segments of the

29. The drawings in figures 1 and 4 have been made by Miss Theodora Bergsland, of the Institute of Pathology, Western Reserve University. The photograph (fig. 2) and the accompanying photomicrograph (fig. 3) have been supplied by that Institute.

lens. During life the fetal nucleus remains relatively unchanged. Like growth rings in a tree, new cortical fibers are constantly being added. They are seen as layers of discontinuity, although they are considered in general as cortex until, particularly in the adult, a new and distinct suture pattern, the senile suture pattern, becomes apparent. The layer within the senile suture pattern is then known as the senile nucleus as far in as the fetal suture line, which remains the fetal nucleus. The peripheral, actively growing area is then termed the senile cortex.

All rats were first examined with the slit lamp, after the pupils had been dilated, when the animals were approximately 3 weeks of age, so that the appearance of the lens was representative of that at the time of weaning. At this time all showed clear corneas, normal anterior segments (except for occasional strands of persistent pupillary membrane) and clear lenses, the fetal suture lines appearing as shown in figure 1 *A*.

The 2 rats which suffered cataract formation on the Day diet showed as an initial change a diffuse clouding at the level of the fetal suture line (fig. 1 *B*). In two additional days the entire fetal nucleus was swollen, opaque and amorphous and did not even permit visualization of the posterior Y suture. At this time no changes were observed in the fetal cortex. Within three weeks following the development of the fetal nuclear opacity, the fetal cortex slowly became opaque to the lens capsule (fig. 1 *C*), despite the addition of riboflavin to the diet.

Rat 9507 was examined with the slit lamp on the eighty-eighth day and showed no evidence of lenticular opacity. On the eighty-ninth day the fetal nucleus of the left eye was completely opaque, the right being entirely clear. On the ninety-first day administration of natural riboflavin as a supplement to the diet was started, 20 micrograms being given daily, six times a week. An immediate response in growth followed, and a new growth of fine silky hair appeared around the genitalia and the eyelids. Twelve days after treatment with riboflavin was started, however, a nuclear cataract developed in the right eye of this rat, and the animal died on the one hundred and forty-first day from pneumonia.

In rat 10262 a nuclear opacity developed in the left eye on the thirty-first day on diet 1 in which S. M. A. casein was used throughout the experiment. Practically no alopecia appeared. Immediately after examination with the slit lamp 120 micrograms of natural riboflavin was injected intramuscularly. Similar doses were injected twice weekly thereafter. An immediate response in growth resulted. The cataract in the left eye continued to maturity, but no cataract appeared in the right eye.

It is to be noted that in the series of 23 rats fed the diet which was deficient in riboflavin and which contained no lactose no suggestion of a senile suture pattern has been seen, even in 1 rat which was kept on the diet for one hundred and sixty-six days. Nor has a senile suture pattern been seen in the 4 rats kept on the diet supplemented with riboflavin. In 1 of the rats fed the diet supplemented with riboflavin for two months,

a senile suture pattern developed three weeks after the diet was changed to the diet high in lactose, despite the fact that a litter mate kept on the Day diet (supplemented) failed to show this maturation of the lens. It is, then, remarkable that the diet deficient in riboflavin allows some deposition of cortex about the fetal nucleus but permits development of only an adolescent lens.

When adequate riboflavin was injected into rat 10262, rapid growth of the body and the external eye followed, but the lens appeared no larger, and the retinoscopic examination did not show high myopia.

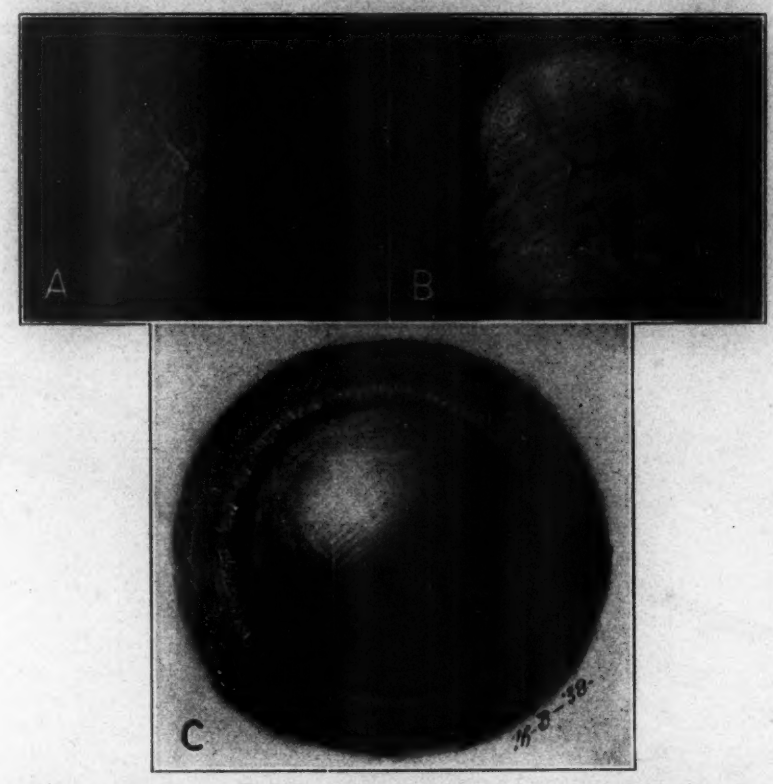


Fig. 1.—*A*, appearance of the normal anterior and posterior fetal Y sutures in the lens of a rat on examination with the slit lamp. *B*, appearance of early opacity at the level of the fetal Y sutures in the lens of rat 10262 fed the diet deficient in riboflavin. *C*, appearance of mature cataract due to a deficiency in riboflavin (as seen in rats 9507 and 10262). The fetal nucleus has become completely opaque, and the opacity has extended through the fetal cortex to the capsule.

One might deduce that growth of the lens had not been retarded to the same extent as had been growth of the external eye, or possibly that dual growth mechanisms were concerned. We do not wish to draw conclusions from these observations, however, because of the difficulty in using the retinoscope during the portion of the experiment that the

animals received the diet deficient in riboflavin, when superficial keratitis and corneal vascularization were so severe.

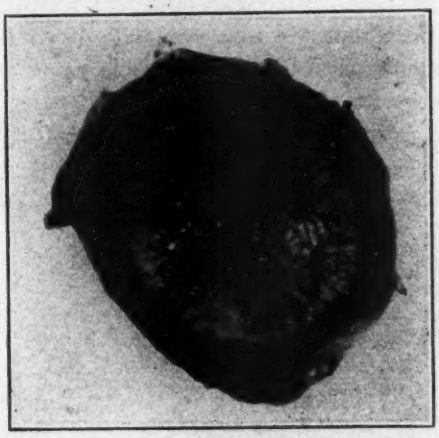

Fig. 2.—Vascularized cornea of rat 10257 on the diet deficient in riboflavin. India ink was injected into the heart before complete corneal section. The iris was removed, and the cornea was fixed to preserve its normal curve.

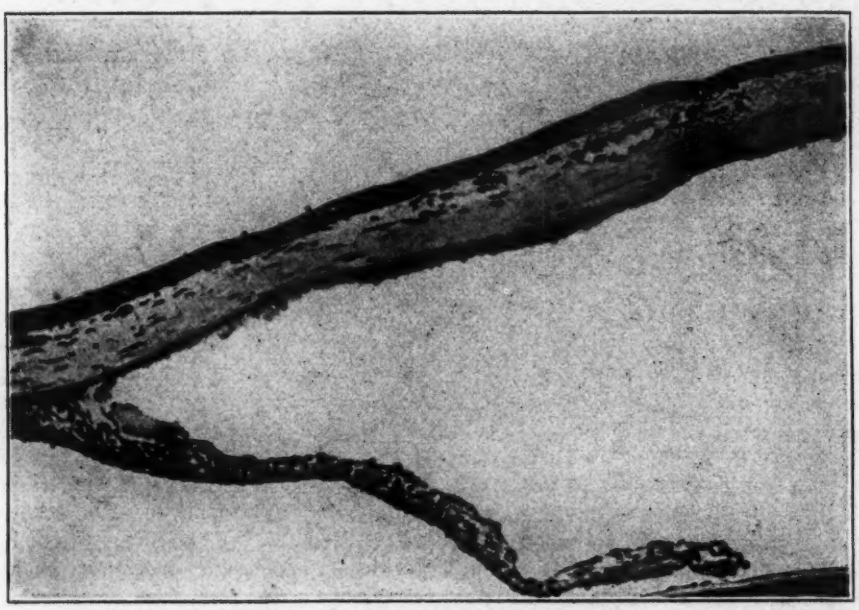

Fig. 3.—Photomicrograph showing superficial vascularization of the cornea of rat 10261 due to a diet deficient in riboflavin.

It is interesting, further, that in rat 10262 the eye which had a cataract failed to show any noticeable external growth after the diet was supplemented with riboflavin, while the unaffected eye appeared to grow externally in proportion to the body in general.

In 12 of the 23 animals on diet 1, vascularization of the cornea or keratitis was recorded, but little importance was placed on these changes in the first experiment, as they were believed to be transitory and not characteristic of riboflavin deficiency. In the second experiment, however, all the rats on diet 1 which had survived to the forty-eighth day showed either keratitis or vascularization of the cornea (fig. 2). The superficial nature of the vascularization is shown in figure 3.

RESULTS OF EXPERIMENTS WITH DIET 2 (70 PER CENT LACTOSE)

One of the 6 rats placed on diet 2 died of an intestinal disturbance on the twentieth day. The remaining 5 rats were considerably stunted in growth for the duration of the experiment. They exhibited no alopecia, but a sanguineous discharge from the eyes was generally present. No internal changes could be observed in the gross specimen on postmortem examination.

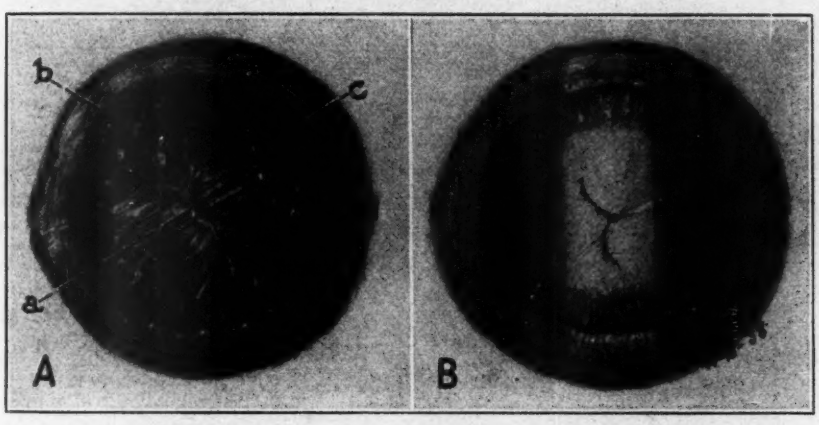


Fig. 4.—*A*, early stage of changes in the lens of a rat fed the diet containing 70 per cent of lactose, showing the senile suture line (*a*), the club-shaped riders (*b*) and the peripheral vacuoles (*c*). These changes were characteristic of those seen in all rats on this diet. *B*, appearance of a cataract due to the diet high in lactose. The vertical band represents the slit lamp beam of light. The senile suture line is anterior to the plane of focus and therefore is not visible. The peripheral riders and vacuoles are visible in the light reflected from the opacity which is forming at the level of the fetal Y suture.

*Ocular Changes in Rats on Diet 2.*—Before they were placed on diet 2, these 6 rats had been examined with the slit lamp at the age of 3 weeks, which represented the time of weaning. At this time only the fetal suture line was visible. Near the end of the third week that the animals were on the diet, examination with the slit lamp through dilated pupils revealed the presence of a definite senile suture pattern in all 6, and at the periphery of the lens there were many small vacuoles immediately beneath the capsule. The fine lines of the lens fibers were visible as they joined the senile suture pattern. At the near periphery

were also seen small club-shaped riders (fig. 4 *A*), similar to those seen in coronary cataracts. During the next seven weeks the process changed in intensity but not in character, the vacuoles appearing and disappearing, to be followed by club-shaped opacities and reduplication of the lens fibers. Ten weeks after the inception of the lactose diet, in the lens of one of the rats an amorphous stratum was seen extending anteriorly and posteriorly around the fetal nucleus at the level of the fetal suture line (fig. 4 *B*). In another week the fetal nucleus was almost solidly opaque, amorphous and structureless and obscured any view of the posterior fetal Y suture. During the following two weeks the senile nucleus gradually became opaque, and all structure was lost except for large vacuoles, which cast a shadow resembling the holes in Swiss cheese. A few of the clear areas radiated toward the center of the lens, similar to the "waterspouts" (*Wasserspalten*) of a human cataract.

The simultaneous appearance of the senile suture pattern in all 6 rats leaves little doubt that the earliest change is a precocious maturation of the senile suture pattern. The association with the club-shaped riders is not clear, for they do not seem to follow the small, early vacuoles, nor do they appear to be related to the fibers in the cortex, yet they are uniformly present.

## COMMENT

The work of Day and his associates has shown the relation between cataract and vitamin G deficiency, evidence having been presented by these workers that crystalline riboflavin will prevent and even arrest cataract in the albino rat. Other investigators have been unable to obtain so high an incidence of cataract and have suggested that contamination of some food constituent with small amounts of riboflavin may be a possible explanation.

In order to eliminate this factor, we used a diet which was identical in every respect with the diet fed by Day and his co-workers. In a portion of our experiments a slightly different brand of casein was employed than that used by Day and his associates, but the response in growth obtained with the different brand of casein would indicate that it is at least as free from riboflavin as was the brand recommended by Day. Consequently, we believe that we may consider all our rats on the Day diet to have been in one group, regardless of the brand of casein used. Cataract developed in 2 of the 23 rats on the diet deficient in riboflavin. Twelve of these rats, however, died before the average time for the appearance of cataract as reported by Day. If these 12 animals are eliminated from our results, the incidence of cataract is raised to 2 cataracts in 11 rats.

The animals for our experiments were placed on the experimental diet when they weighed less than 40 Gm., which is within the limits recommended by Day. For the second experiment they were taken from litters of more than 8 animals; this selection had no effect on the incidence of cataract. With the same method of handling, we are consistently able to obtain the symptoms of vitamin $B_6$ deficiency in animals placed on a diet deficient in vitamin $B_6$.[30] If specific symptoms, such as production of cataract, are to be used as an assay for deficiency of a vitamin, we believe that they should be readily duplicated by other workers.

Sebrell, Onstott and Hunt [31] have found changes in the livers of dogs kept on a diet deficient in riboflavin. For the present, they have termed these changes "yellow liver." The hepatic changes which we found in the 13 rats on this diet appeared to be similar macroscopically to the changes described by Sebrell and his co-workers.

From our experience with the diet deficient in riboflavin, the most consistent ocular change was the appearance of corneal vascularization, since cataract developed in only 2 of 23 of our rats on this diet, while superficial vascularization of the cornea developed in 12, and several animals died before this observation was made. After riboflavin was added, the most uniform effect was remission of the vascularization. The 3 mature cataracts that did develop in 2 rats did not regress but rather increased in extent despite the administration of riboflavin. Although a superficial keratitis usually preceded the vascularization, it was present less permanently and often cleared spontaneously when the diet was not supplemented with riboflavin.

Previous descriptions [32] of galactose cataract have not included the rapid development of the senile suture line. All the animals which we placed on the diet containing 70 per cent of lactose exhibited this suture line in nearly three weeks. None of the rats on the lactose-free Day diet showed a senile suture line, not even an animal at the age of 6 months. We studied a large number of presumably normal rats kept on the Sherman stock diet,[33] and the youngest rat in which we found

30. Birch, T. W.; György, P., and Harris, L. J.: The Vitamin $B_2$ Complex. Differentiation of the Antiblacktongue and the "P.-P." Factors from Lactoflavin and Vitamin $B_6$ (So-Called "Rat Pellagra" Factor), Biochem. J. **29**:2830, 1935.

31. Sebrell, W. H.; Onstott, R. H., and Hunt, D. J.: The Treatment of Black-Tongue with a Preparation Containing the "Filtrate Factor," and Evidence of Riboflavin Deficiency in Dogs, Pub. Health Rep. **52**:427, 1937.

32. Mitchell, H. S., and Cook, G. M.: Galactose Cataract in Rats: Factors Influencing Progressive and Regressive Changes, Arch. Ophth. **19**:22 (Jan.) 1938.

33. This diet consisted of a mixture of two thirds ground whole wheat and one third whole milk powder, as modified by A. H. Smith and F. C. Bing (Improved Rate of Growth of Stock Albino Rats, J. Nutrition **1**:179, 1928) with calcium carbonate and sodium chloride each 1 per cent of the weight of the wheat, and supplemented with 1 to 5 per cent of yeast and wheat germ.

a senile suture line was 10 weeks of age. The Sherman ration, however, contains about 12 per cent of lactose, a fact which probably influences the maturity of the lens.

Would a senile suture line develop in a rat reared from weaning on a diet free from lactose to an age comparable to 50 years in the human being? We cannot say that a deficiency of lactose will prevent the appearance of the senile suture line, but we have seen that the presence of lactose in the diet promptly causes the senile suture pattern to become visible.

No senile suture pattern was visible in a rat which had been raised for two months on the Day diet supplemented with riboflavin. When this animal was shifted to a diet high in lactose, or when 15 cc. of 20 per cent solution of galactose was injected daily, a senile suture pattern promptly became visible. The injection of 15 cc. of a 20 per cent solution of galactose seemed to have a toxic effect on the animal and therefore could not be continued long, but the development of the senile suture pattern was so rapid that the effect of the galactose could be observed before the death of the animal occurred. The results with injection of the solution of galactose indicate that the effect of the lactose or galactose on the maturation of the lens is not due to changes in the intestinal tract.

Just how galactose influences the crystalline lens is not understood. It has been found that in rats rendered cataractous by feeding high levels of lactose or galactose the sugar content of the blood is increased,[34] the content of calcium in the lens is increased,[17] and the glutathione content of the lens and the oxidation-reduction potential of the center of the lens are both reduced.[35] Galactose has a greater toxic effect than have other carbohydrates on tissue cultures of lens epithelium.[36] When the aqueous humor of the lens was aspirated and replaced by an isotonic solution of galactose, the glutathione content of the lens was not affected,[35] but it was greatly reduced when rats were rendered cataractous by the administration of galactose.[35] These authors have also found that senility in the rat is accompanied by a reduction in the content of glutathione in the lens. From their chemical studies they have concluded that "galactose seems to have an effect similar to the process of aging."[37] This statement is now doubly significant, for their

34. Day, P. L.: Blood Sugar in Rats in Which Cataract Was Produced by a Vitamin G-Deficient Diet and by a Lactose-Containing Diet, J. Biol. Chem. **109**: xxvi, 1935. Yudkin and Arnold.[20]

35. Bellows, J. G., and Rosner, L.: Studies on Galactose Cataract, Am. J. Ophth. **20**:1109, 1937.

36. Kirby, D. B.; Estey, K., and Wiener, R. v. E.: A Study of the Effect of Changes in the Nutrient Medium on Lens Epithelium, Cultivated "in Vitro," Tr. Am. Acad. Ophth. **37**:196, 1932.

37. Bellows and Rosner,[35] p. 1112.

work on the chemistry of the lens and our work on the structure of the lens as evidenced by the appearance of the senile suture line both point to the conclusion that administration of galactose produces a rapid maturation of the lens.

## SUMMARY

We were able to obtain cataract in 2 of 23 rats kept on a diet deficient in riboflavin. Inclusion of riboflavin in the diet did not prevent the cataract from progressing to maturity and in 1 instance did not prevent a cataract from forming in the second eye. The cataract started as an opacity of the fetal nucleus. Keratitis and vascularization of the cornea were more consistent ocular changes than cataract and were improved by addition of riboflavin to the diet; they did not occur in animals kept on the Day diet supplemented with riboflavin.

All rats fed a diet high in lactose had a senile suture pattern in three weeks, which was accompanied by peripheral vacuoles as well as by club-shaped riders similar to those seen in coronary cataracts. The senile suture pattern was not observed in any of the rats on the lactose-free diet. When mature cataract appeared, it started as an opacity in the fetal nucleus. Lactose in the diet or injection of galactose caused rapid maturation of the lens as evidenced by the appearance of the senile suture line. Vascularization of the cornea was never observed in the rats on the diet high in lactose.

# AUTOMATIC TREPHINE FOR GLAUCOMA

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AND
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It is doubtless true that the perfect operation for glaucoma has not been developed as yet, and the great number of operations that have been and are being used attests this fact. In a brief survey, the broad basal iridectomy devised by von Graefe in 1885 was followed after some twenty years by Lagrange's operation of sclerectomy, which in turn was succeeded in popularity by Elliot's trephine operation. While other procedures, such as cyclodialysis, iridectomy, iridotomy and posterior sclerotomy, have been found useful and sufficient by some ophthalmic surgeons, the trephine operation has withstood the test of time better than any other. We believe it to be right in theory and correct from a mechanical point of view, but, nevertheless, in practical application the operation is followed by many failures, a large percentage of which probably are due to faulty instruments or to ineptness of the operator.

When properly performed, the operation causes a minimum amount of trauma to the eye, and this, we believe, is the most important factor in success. From our own experience [1] we have considered excessive trauma as the chief cause of failure, and most often this has been due to pressure on the eyeball by the operator or his assistant, to traction on the iris and more especially to dull blades and mechanical imperfections of hand trephines. A light automatic trephine is easy to manipulate, and when armed with a sharp blade and given the proper speed of revolution it will overcome most of the technical difficulties. The proper speed of revolution should be emphasized, for when it is too slow aqueous may escape before a sufficient amount of iris has protruded to do an iridotomy, and if it is too rapid the iris will present too suddenly for the proper performance of the iridotomy. The trephine shown in figure 1 has the advantages cited. Its use for over ten years has reduced our complications to a small percentage, and this in turn has resulted in many more operative cures and a marked decrease in the period of hospitalization.

1. Green, A. S.; Green, L. D., and Green, M. I.: New Automatic Trephine, Arch. Ophth. **6**:752 (Nov.) 1931.

Preparatory to operating, we instill 3 drops of a 0.25 per cent solution of physostigmine salicylate U. S. P. into the eye at intervals of ten minutes and commencing one hour before the operation. If possible, the pupil should be contracted to pinpoint size in order to minimize the amount of prolapse of the iris before iridotomy. The deep structures

Fig. 1.—The new automatic trephine.

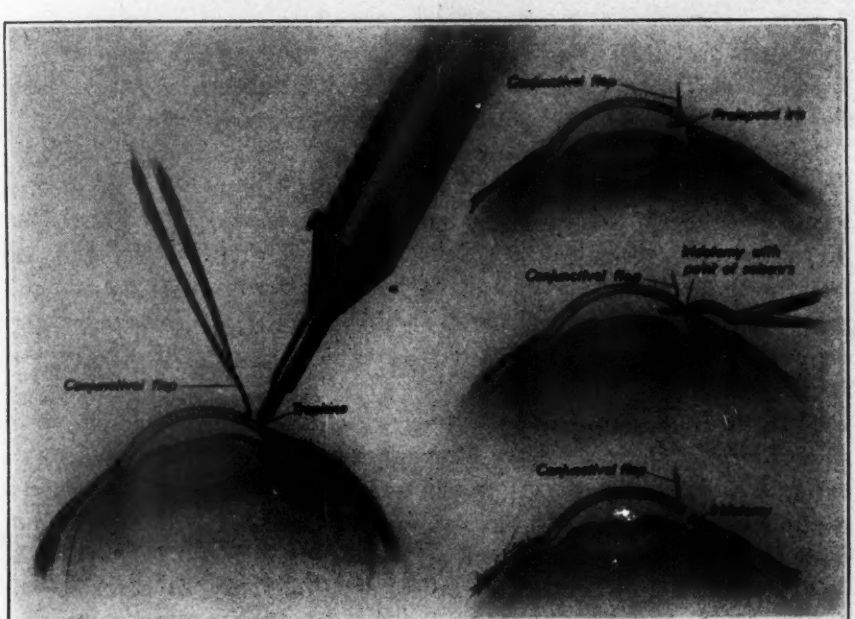

Fig. 2.—Operative technic, showing new trephine in action.

of the eye are anesthetized by the intraorbital injection of 1 cc. of a 4 per cent solution of procaine hydrochloride, followed by 1 drop of a 4 per cent solution of cocaine hydrochloride, which is instilled into the cul-de-sac every five minutes until 3 or 4 drops have been given. The conjunctiva is dissected downward in the manner of Elliot to about 1 mm. beyond the limbus, so that a blue crescent of cornea is seen. This is best accomplished with a dull keratome.

The trephine must be wound up fully, and just before it is applied to the globe the release button should be pressed down for an instant to make certain that the blade is revolving. The trephine is applied without pressure lightly to the spot where the disk is to be cut. This spot is so selected that it will include half cornea and half sclera. The release button is pressed, but the instrument is withdrawn after two or three revolutions in order not to penetrate too suddenly. It is then reapplied, and the disk is cut through. With a little experience one can judge quickly the amount of pressure necessary. The cutting edge of the blade is superlatively sharp; it has a small shoulder slightly less than 1 mm. from the edge, which prevents the blade from penetrating too deeply into the eye. The blade comes in two sizes, 1.25 mm. for the eye with high tension and 1.75 mm. for the eye with low tension. The assistant should be ready with the iridotomy scissors, for the moment that the iris presents in the wound in the form of a hemisphere it is to be snipped and the aqueous permitted to escape; otherwise too much iris is liable to prolapse into the wound. If the corneoscleral disk has not been detached completely by the trephine, it may be cut off with the scissors. The pupil should resume its round form, and the iris will have no hole, for an iridectomy has not been done. The conjunctiva is closed with a watertight suture.

If at the close of the operation the pupil should be slightly drawn up rather than round, it may be returned to its normal position and shape by the simple maneuver of raising both lids away from the ball with a speculum. Should this prove insufficient, the lid covering the eye should be massaged gently over the pupillary area. The sutures are removed in three or four days.

We have been using this technic with the most satisfactory results since March 1930. We have been impressed strongly by the fact that with the use of the automatic trephine we rarely meet the complication of postoperative cataract, a complication which has been only too common with the use of the hand trephine. T. H. Butler [2] in 1932 reported an incidence of 10 per cent in 50 cases. The operation as described may be employed for all forms of glaucoma; it is as efficacious for the acute as for the chronic form.

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2. Butler, T. H.: Iridencleisis and Trap-Door Iridectomy in the Treatment of Glaucoma, Brit. J. Ophth. **16**:741 (Dec.) 1932.

# AN OPERATIVE PROCEDURE FOR GLAUCOMA OF SHALLOW CHAMBER TYPE

## MULTIPLE EXCISIONS OF THE ROOT OF THE IRIS AND DEEPENING OF THE ANTERIOR CHAMBER

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Primary glaucoma may, with few exceptions, be divided into two great anatomic types [1] according to the mechanical cause of the increased intraocular pressure. One type is characterized by a normal or deep chamber and an open iridic angle (fig. 1) in which the increased pressure is caused by blockage of the sclerocorneal trabeculum. A rational operation, "goniotomy," [2] was suggested for its relief. The second type is characterized by a shallow chamber and a narrow angle and is produced by obstruction of the filtration angle by the root of the iris (fig. 2). An operative procedure for this type of glaucoma is herewith presented. This operation is equally adapted to the late stages in which adhesions have *not* formed and as a preventive or prophylactic operation in the early stages. It may also be employed with safety and without complicating sequelae in those cases in which the intraocular tension is very high and the condition threatens to become malignant. Secondary glaucoma may be similarly divided into two main types, and the same operative procedures may sometimes be applied.

### MECHANICAL ETIOLOGY OF SHALLOW CHAMBER TYPE OF PRIMARY GLAUCOMA

According to recent microgonioscopic and surgical investigations, the mechanical cause of the increased intraocular pressure in this type of primary glaucoma (as well as in secondary glaucoma of the shallow chamber type, such as in retinitis pigmentosa) appears to be closure of the entrance to the filtration angle by the root of the iris. This type of glaucoma may be described from an anatomic and causal point of view

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Read before the Section on Ophthalmology at the Eighty-Ninth Annual Session of the American Medical Association, San Francisco, June 16, 1938.

1. Barkan, O.: A New Operation for Chronic Glaucoma: Restoration of Physiological Function by Opening Schlemm's Canal Under Direct Magnified Vision, Am. J. Ophth. **19**:951-965 (Nov.) 1936.

2. Barkan, O.: Technic of Goniotomy, Arch. Ophth. **19**:217-233 (Feb.) 1938.

as "narrow angle or shallow chamber" glaucoma. There is evidence to suggest that it is increase of vitreous pressure and volume that pushes the iris lens diaphragm forward, with consequent narrowing of the angle and its closure. At first the closure is one of contact only, the root of the iris being pushed into it. In the course of time or when

Fig. 1.—Deep chamber type of chronic glaucoma. Photograph of a model showing the microgonioscopic appearance of the angle of the anterior chamber. The trabecular pigment band is shown on the left; the normal iris processes or uveal meshwork on the right. *A* indicates a cross section of Schlemm's canal; *B*, the trabecular pigment band showing obstruction of that portion of the sclerocorneal trabeculum which covers Schlemm's canal; *C*, the internal annular ring of Schwalbe; *D*, the iris processes or uveal meshwork; *E*, the iris; *F*, the sclerocorneal trabeculum, and *G*, the cornea.

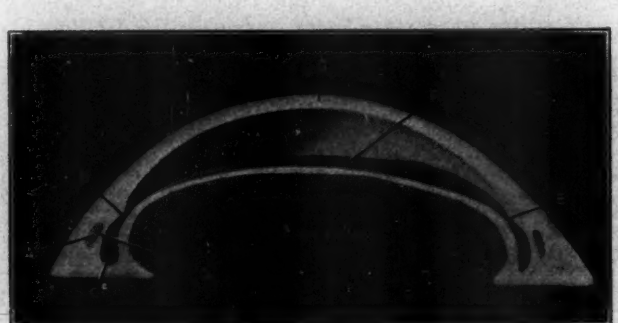

Fig. 2.—Shallow chamber type of chronic glaucoma. Photograph of a model showing the microgonioscopic appearance of the anterior displacement of the iris, a shallow anterior chamber and a narrow entrance to the angle. *A* indicates Schlemm's canal; *B*, the internal annular ring of Schwalbe; *C*, the sinus of the angle; *D*, the sclerocorneal trabeculum; *E*, the narrow entrance to the angle; *F*, the anterior surface of the iris; *G*, the cornea, and *H*, the posterior surface of the iris.

congestive transudation occurs as a result of the obstruction, permanent adhesions form. These aggravate the mechanical obstruction and complicate its correction.

Shallowness of the anterior chamber is the underlying anatomic predisposition in those cases in which the condition has heretofore been described clinically as "prodromal," "chronic congestive" or "acute congestive" glaucoma. The same holds true for certain cases in which the condition has heretofore erroneously been described as chronic simple glaucoma because the course was clinically noncongestive, but the chamber was shallow. It is striking how much the visual field may be contracted in these cases in which the anterior chamber is shallow and the condition has been noncongestive but adhesions have not formed. Thus functionally the condition may be regarded as being in the late stage, whereas anatomically and surgically it is still, in view of the absence of adhesions, in the mechanically uncomplicated early stage.

The importance of such anatomic considerations as described here would seem to consist in this: If the mechanical cause or predisposing factor of increased intraocular pressure can be definitely determined, then it should be possible to choose a suitable operation, the results of which could be definitely predicted both in the early stage, before damage to the tissues from pressure has occurred, as well as in the later stage of high degree of tension, when a too sudden reduction of tension might initiate a malignant course. It was with these objectives in mind that the combined procedure described here was devised.

### ACTION OF IRIDECTOMY IN SHALLOW CHAMBER TYPE OF GLAUCOMA

Biomicroscopic (microgonioscopic) observation of the angle of the anterior chamber before and after operation confirms the older theories that the iridectomy of von Graefe reduces pressure by freeing the filtration angle of iris tissue and maintaining patency by excision of a piece of the root of the iris. The action of iridectomy accomplishes three things: 1. It insures access of aqueous to that part of the trabeculum which is exposed and into neighboring parts of the sinus of the angle behind the pillars of the coloboma. 2. It equalizes pressure before and behind the iris diaphragm. 3. This in turn causes recession or posterior displacement of the diaphragm, which widens the entrance to the filtration angle in this region, preventing further occlusion and permitting continued access of aqueous to the angle.

Microgonioscopic investigations before and after iridectomy (in which no accidentally filtering scar was formed) show that in cases in which the operation is permanently successful all three of these features are present, whereas when one or more are lacking the result is correspondingly imperfect, and when all are absent the operation is a complete failure. In some cases the original situation may even be made worse, owing to further closure of the angle by postoperative peripheral adhesions. I believe that it can be shown in many cases that the inadequacy of the iridectomy of von Graefe, or of the peripheral

iridectomy of Pfluger and Hess or of the iridotomy of Curran,[3] both single and multiple, can be accounted for by their failure to satisfy one or more of the foregoing demands, which are essential to a permanently successful result.

### TECHNICAL DIFFICULTIES AND INADEQUACY OF IRIDECTOMY IN SHALLOW CHAMBER TYPE OF GLAUCOMA

Iridectomy is inadequate as an early operation in cases of glaucoma of the shallow chamber type in which peripheral adhesions have not yet formed and in the presence of good central vision, because it mutilates the pupil, causes glare and astigmatism and more often than not necessitates the wearing of glasses which were not needed before. It is furthermore exposed to the criticism of uncertainty of action, since incarceration of iris, postoperative adhesions in the angle or other technical imperfections may easily occur owing to the shallowness of the chamber and in cases of high intraocular pressure precipitate a malignant course.

The main technical difficulty of iridectomy in cases of glaucoma of the shallow chamber type consists in entering the knife in such a way as to obtain an adequate basal excision of the root of the iris without resultant injury to the intraocular contents or to ultimate visual function. Various methods, such as posterior sclerotomy, intravenous injection of dextrose and retrobulbar injection of epinephrine hydrochloride, have been employed to prevent too sudden reduction of tension and forward propulsion of intraocular contents in cases of high tension. Incision "ab externo" has been recommended for the same purpose, but this is inadequate as it encourages the formation of peripheral adhesions, which increase the obstruction at the angle.

In addition to technical difficulties, the lack of indications as to which cases were suitable has led to inadequacy of iridectomy. Frequently in the past iridectomy has been wrongly applied to the open angle and normal or deep chamber type of glaucoma or to the narrow angle and shallow chamber type in the late stage with organic adhesions in the angle.

As a result of these difficulties and inadequacies and of the danger of initiating a malignant course, substitute operations for iridectomy, such as trephination, iridencleisis and cyclodialysis, were devised and commonly accepted as the operations of choice in *all* cases of chronic glaucoma. These operations are palliative, but they do not relieve the cause of the increased intraocular pressure. Moreover, they are

3. Curran, E. J.: A New Operation for Glaucoma Involving a New Principle in the Etiology and Treatment of Chronic Primary Glaucoma, Arch. Ophth. **49**: 131-155 (March) 1920.

often unsuccessful and not infrequently initiate a new and serious pathologic change. Evidently they are not suited to early operation in an as yet well functioning and seeing eye. The conscientious surgeon who knows that early operation is indicated in a given case to preserve function and prevent further organic deterioration hesitates to apply such dangerous and mutilating operations. It is evident that an operation which safely restores the physiologic direction of outflow of intraocular fluid would be preferable to those that establish an abnormal outlet and create new and dangerous difficulties.

To be adequate, an operation for glaucoma of the shallow chamber type should widen the entrance to the angle over at least one half or more of its circumference, preferably the upper portion, because this is normally the narrower and is the first to close and also because of later appearance.

## NEW OPERATION

It occurred to me [4] that the desired effect could be obtained with both safety and ease by deepening the anterior chamber [5] before, during and at the end of the operation by injecting saline solution and then excising a small piece of the root of the iris at one or preferably several points along its circumference. Posterior sclerotomy facilitates the deepening in cases in which the vitreous is liquid. In cases in which the vitreous is solid or there is high vitreous pressure and a very shallow chamber and there is a possibility of a malignant course, aspiration of 0.5 cc. of vitreous with a syringe may be employed advantageously.[6] Injection of the anterior chamber as the final step of the operation results in deepening and permanent restoration of the chamber, thus preventing the formation of adhesions in the angle. Such excisions of the root of the iris when performed through several appropriately placed small incisions instead of through a single large one can be made to include as large an area of the circumference as desired without any untoward sequelae. It is evident that this cannot be accomplished by means of classic total iridectomy without so large an incision and opening of the

4. Barkan, O.: Glaucoma: Classification, Causes and Surgical Control (Results of Microgonioscopic Research), Am. J. Ophth. **21**:1099-1117 (Oct.) 1938.

5. Deepening of the anterior chamber has been described and employed by H. J. Howard (A Method of Deepening the Anterior Chamber in Glaucoma and Cataract Operations, Am. J. Ophth. **18**:461-462 [May] 1935) to facilitate the entrance of the knife into a shallow chamber. I have found it to be more effective and more easily controlled when preceded by aspiration of vitreous.

6. Aspiration of vitreous has been frequently employed for the removal of opacities of the vitreous by M. zur Nedden (Das Instrumentarium zur Glaskörperabsaugung, Klin. Monatsbl. f. Augenh. **66**:474-476, 1921) and appears to be a harmless procedure. It appears, in my opinion, to be clinically a useful and justifiable procedure in certain cases of glaucoma of the shallow chamber type and to be preferable to loss of nonfluid vitreous through posterior sclerotomy incision.

eyeball as to endanger and grossly disfigure it. In the 15 cases in which operation has been done to date with the technic described here there has been but little traumatism, the sphincteric action of the pupil has been maintained and there has been almost complete absence of postoperative astigmatism or of other refractive errors as well as of postoperative adhesions in the angle. The operation may appropriately be called "multiple excisions of the root of the iris combined with deepening of the anterior chamber."

## INDICATIONS

The procedure is indicated as an early operation in cases of glaucoma of the shallow chamber type without adhesions; it is also especially suited to those cases of the shallow chamber type in which because of extremely high tensions and shallowness of the chamber a malignant course may be feared, provided no extensive organic adhesions are present.

## TECHNIC

The technic of the operation follows:

1. The pupil should be miotic, the eye having been well treated with physostigmine salicylate before the operation.

2. Local preparation is the same as for any intraocular operation. The lashes of the lids should be clipped.

3. Akinesis is secured in the usual way.

4. Local anesthesia is obtained by means of instillation of drops of 1 per cent pontocaine hydrochloride.

5. Four per cent procaine hydrochloride (without epinephrine) is injected into the superior rectus muscle. This helps downward rotation sufficiently to dispense with a suture in the muscle.

6. One cubic centimeter of a 4 per cent solution of procaine hydrochloride with the addition of 1 drop of epinephrine hydrochloride (1:1,000) is injected retrobulbarly.

7. The speculum is inserted.

8. The technic of posterior sclerotomy follows: After a small flap of conjunctiva is turned back, the lower outer quadrant of the sclera is punctured with a cataract knife. In cases in which the vitreous is liquid or in those in which the pressure is not too high, posterior sclerotomy facilitates subsequent deepening of the anterior chamber by means of injection. In some cases in which the vitreous pressure is very high or in those in which the vitreous is not fluid, posterior sclerotomy does not soften the eyeball nor does it facilitate the subsequent deepening, since no vitreous has been lost. In these cases and in those in which the chamber is very shallow and a malignant course threatens,

aspiration of 0.5 cc. of vitreous with a zur Nedden needle,[7] with a lumen of 0.6 or 0.7 mm. inserted toward the center of the bulbus (up to the ball of the zur Nedden needle) may be advantageously employed. This aspiration of vitreous adequately reduces excess vitreous pressure and prevents the iris lens diaphragm from being pushed forward to block the wound and angle when the anterior chamber is evacuated. In the cases in which it is indicated it prevents the possibility of a malignant course more certainly than posterior sclerotomy alone or when combined with deepening of the chamber. It softens the eyeball but does not in itself deepen the anterior chamber appreciably. It facilitates the later deepening by the injection of salt solution, since the latter is not so readily accomplished without a preliminary reduction in the volume of vitreous.

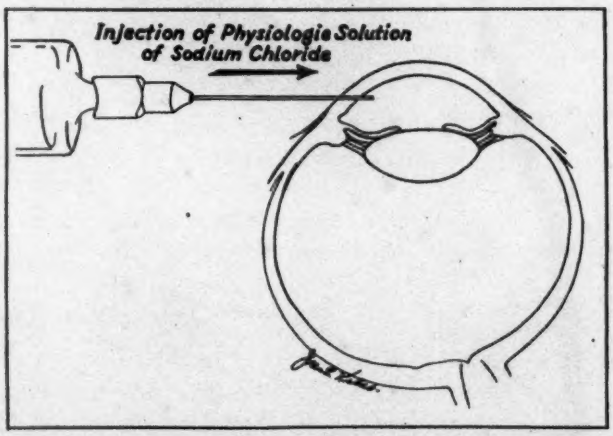


Fig. 3.—Second step of the operative procedure—deepening of anterior chamber by means of injection of physiologic solution of sodium chloride.

9. The anterior chamber is deepened by means of an injection of physiologic solution of sodium chloride. The eye is fixated at the nasal limbus with an Elschnig forceps. The incision is made with another Graefe knife, the puncture being placed within corneal tissue about 1 mm. from the temporal sclerocorneal border in the horizontal meridian and oblique so that the inner end of the incision is situated at least half way or more to the pupil (fig. 3). Next a 2 per cent solution of fluorescein is dropped on the cornea in order to render the puncture plainly visible, and the tip of a dried iodine applicator is placed

7. Zur Nedden punctured the sclera directly with his needle from 5 to 6 mm. posterior to the limbus. I believe that it is preferable to place the posterior sclerotomy with a Graefe knife before inserting the needle 6 mm. posterior to the limbus or in the lower outer quadrant.

on the wound for a moment. A 29 bore steel needle with blunt edges [8] and attached to a 1 cc. Luer syringe is inserted into the anterior chamber with strictest asepsis. Physiologic solution of sodium chloride is injected into the chamber until the iris diaphragm is pushed well back. A circular concave trough of iris is seen to form around the lens, the posterior chamber having disappeared. Deepening and injection of the anterior chamber facilitate the proper execution of the next step of the operation, namely, placement of the keratome incisions and excisions of the root of the iris from underneath the limbus.

10. The eye is now fixated at the lower limbus with an Elschnig or three-pronged forceps, and an oblique incision with a sharp keratome

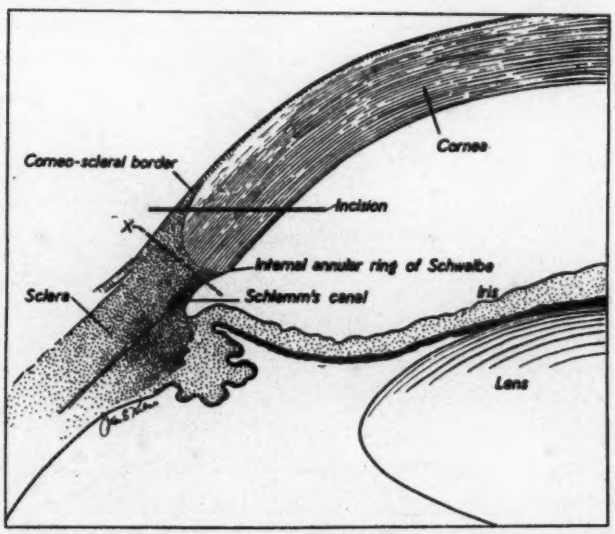


Fig. 4.—Diagram to demonstrate the surgical relations of the angle of the anterior chamber and the limbus. The chamber has been deepened. Note the position of the valve keratome incision in this procedure. The dotted line at *X* shows the usual direction of the keratome incision for iridectomy in cases of glaucoma.

is made beginning not more than 1 mm. scleral to the corneoscleral border (fig. 4). The incision thus starts just within scleral tissue. Proceeding obliquely, it almost immediately comes to lie within corneal tissue, since this part of the limbus is made up mainly of corneal tissue, only the outer layer consisting of scleral fibers. It is well known that incisions in scleral tissue tend to gape whereas the lips of a corneal incision tend to approximate. To this natural closing tendency of corneal tissue is added the marked tendency of an oblique corneal

8. If the edges of the needle have not been dulled, the tip is likely to catch in the walls of the oblique wound canal or in Descemet's membrane.

incision to close in the manner of a valve. Closure of the incision is immediate, and the anterior chamber becomes reestablished spontaneously within a short time, since there is no seepage from the wound. Furthermore, the chamber may be artificially restored and deepened by means of an injection at any time during the course of or after completion of the operation.

The advantages of restoring, maintaining and deepening the anterior chamber are manifold. It prevents intraocular hemorrhage by maintaining intraocular pressure; it avoids incarceration of the pillars of the iris and assures a perfect mechanical result in that the patient leaves the operating room with a deep chamber, an open angle and no chance of further loss of aqueous or collapse of the chamber; postoperative adhesions of the iris in the angle are thus effectively prevented. When the incision is properly placed and in spite of the inner (corneal) lip of the wound being considerably anterior to the entrance of the angle (the internal annular ring of Schwalbe) and to the border of Descemet's membrane, it is yet easy to grasp the iris near enough to its root with a special iris forceps[9] to assure excision of the root of the iris but to leave the sphincter intact. Deepening of the chamber (posterior displacement of the iris diaphragm) makes it possible to give the desired placement and direction to the corneal incision and also to grasp the iris near its root.

Deepening of the anterior chamber must be done with strictest asepsis. The wound of entry should be touched with a dried iodine applicator each time before the insertion of a needle, and a new needle should be used each time. It is well to have five needles prepared. In one case in which asepsis was insufficient a subacute iritis developed, which, however, was promptly controlled by the intravenous injection of typhoid vaccine and local treatment, the end result being excellent.

Three successive keratome incisions and peripheral iridectomies (fig. 5) are performed in the manner described. (One excision performed in this manner is sometimes sufficient.) It is usually found necessary to deepen the chamber with an injection of saline solution after the completion of each iridectomy. The chamber should be deep and the angle open before the patient leaves the operating table.

In order to prevent adhesions of iris to the inner lip of the wound it is sometimes necessary to use a spatula, and on two occasions I have found it convenient to relieve an anterior threadlike incarceration of iris by means of a sweep of the end of the injection needle while it was inside the anterior chamber.

9. This forceps and the needle may be obtained from Storz Instrument Company, St. Louis.

### POSTOPERATIVE CARE

At the completion of the operation, a 1 per cent solution of physostigmine salicylate is instilled, and an ointment containing 1 per cent of physostigmine salicylate is applied. The pupil should be miotic during the first week after operation in order to keep the root of the iris out of the angle. If there is a tendency toward formation of posterior pigment adhesions it may be necessary to dilate (temporarily) the pupil with a 2 per cent solution of epinephrine hydrochloride or with the same drug in a dilution of 1 : 100. This should be done with due caution, however, since the chamber is shallow in this type of glaucoma, and mydriasis may close the remaining angle and increase pressure. The end result of the operation is schematically shown in figure 6.

Fig. 5.—Appearance of eye one year after operation.

### DISPERSION OF PIGMENT

The surgeon will often find a moderate amount of dispersion of pigment from the posterior layer of the iris at the time of iridectomy or when the iris is pulled through the wound. This would seem to denote a high degree of friability of the pigment epithelium of the iris in this shallow chamber type of glaucoma. The dispersion does not appear to be sufficient to block the interspaces of the trabeculum and cause secondarily a "trabecular block."

### MULTIPLE EXCISIONS OF THE IRIS ROOT "AB EXTERNO"

In order to avoid the need of making an injection into the anterior chamber or of aspirating vitreous, another technic was tried in a few cases. This consisted in making multiple incisions and basal iridectomies

"ab externo." Although it was possible to perform multiple excisions of the root of the iris in this manner, the location of the incisions within scleral tissue (in spite of the obliquity of the wound canal) delayed complete closure of the wound sufficiently to permit and encourage the formation of peripheral adhesions of the iris in the angle. These not only interfere with adequate reduction of intraocular pressure but in themselves may produce increased pressure. The latter technic, "ab externo," was therefore discarded in favor of the first described technic of multiple excisions of the root of the iris through oblique keratome incisions combined with deepening of the chamber. This appears to be adequate and without danger so long as proper aseptic precautions are observed.

### EARLY OPERATION

Early operation in cases of glaucoma has in the past been the subject of much discussion. It has been advised by its protagonists in

Fig. 6.—Photograph of a model showing the postoperative microgonioscopic appearance. *A* indicates Schlemm's canal; *B*, the internal annular ring of Schwalbe; *C*, the sinus of the angle; *D*, the sclerocorneal trabeculum; *E*, widening of the entrance to the angle and posterior displacement of the iris diaphragm in the region of the coloboma on the left and only slight widening of the entrance to the angle on the right, beyond the region of operation; *F*, the anterior surface of the iris; *G*, the cornea, and *H*, the posterior surface of the iris.

the shape of iridectomy, external drainage operation (trephination) and internal drainage (cyclodialysis) before injury to the optic nerve should have occurred. Its antagonists, on the other hand, have combated this point of view because these operations involve undue risks and are too often followed by specific complications or dangerous sequelae to justify their being used in the well functioning eye with good vision. However, the question of early operation could not up to the present be discussed on its merits because the different forms of glaucoma have not been sufficiently distinguished from one another as anatomic or causal entities and because no present day operation, except

that of Curran (and this has not found favor except in the hands of the very few), has been directed against the mechanical cause of the increased intraocular pressure which is not a woefully crude, inadequate or mutilating procedure to inflict on a relatively well functioning eye. As regards iridectomy, microgonioscopy shows that it often results in peripheral adhesions of the iris, which in turn increase the intraocular pressure, not to mention the glare and disfigurement resulting from it. Furthermore, in cases of glaucoma of the shallow chamber type with very high tension, it may be followed by a malignant course and vision or even the eye be lost.

A safe, early operation for glaucoma would seem to be the crying need today. Since one of the features of the procedure described in this article is its adaptation to early operation, it is well in this connection to divide the shallow chamber type of glaucoma into an early and a late stage according to whether adhesions between the iris and the angle have formed. The present preliminary report deals, therefore, in the main with cases of the chronic shallow chamber type of glaucoma *before adhesions have formed in the angle.*

The presence or absence of adhesions can be diagnosed by means of the binocular microgonioscopic method. A drop of intraocular pressure to normal following the instillation of a solution of physostigmine salicylate is suggestive of their absence. If desired, this can be confirmed by means of a diagnostic injection and deepening of the anterior chamber followed by gonioscopy. In 1 case this was done as a successful diagnostic procedure on the operating table preliminary to operation.

### ON ADEQUATE SURGICAL PROCEDURES IN GLAUCOMA

For the purpose of choosing the proper surgical procedure, cases of glaucoma should be divided into types and the individual case into stages so that the operative procedure may be suited and adjusted to the particular type and stage. That the operation for glaucoma has been far removed from this ideal is evident. The knowledge of the pathogenesis of glaucoma has not been sufficiently advanced to date to permit of typing on a causal basis, and most operative procedures have acted in a purely palliative manner and not been directed against the cause.

In speaking of adequate operation and in suggesting a classification according to which the operations are chosen to suit, as well as they may, the demands of the individual case, I am well aware of the complexities and difficulties of the situation and realize that compromises must perforce be made in order to obtain the greatest good for the particular organ or for the individual. Since operation cannot restore

what has been destroyed and one can hope only to arrest the process of destruction and prolong the life of the organ, one occasionally may have to be content if only part of this objective is achieved.

### POSTOPERATIVE USE OF MIOTICS

In discussing an adequate procedure for the surgical relief and prevention of chronic glaucoma the practical question arises of the relative importance of dispensing with the need of using miotics in a given case and of the desirability of reducing the pressure to "standard" normal in every case without the use of miotics. Should avoidance of miotics be a necessary concomitant of successful operation in cases of glaucoma of the shallow chamber type? I do not feel that this is so when one considers, for instance, that in an individual case of this type function will be maintained for the rest of the patient's life by operation combined with the occasional use of "drops" with less hazard, less mutilation and through the application of a more physiologic principle than by a more radical type of operation which would insure the complete riddance of the use of "drops" in only that percentage of cases in which it happened to be successful and at the cost of greater dangers. Moreover, in my personal experience, in glaucoma of the shallow chamber type the optic nerve is considerably less likely to suffer from slight nocturnal rises of pressure than in the normal or deep chamber variety. To the normal or deep chamber type belong those cases of long duration in which there is increased tension only during the early morning hours and in which these slight diurnal rises are the straw that finally breaks the fibers of the optic nerve. In them the pressure must perforce be normalized during these hours by operation without the use of eye "drops."

Speaking generally, it would seem to me that preservation of function rather than the absolute pressure should be regarded as the criterion of what is to be demanded of operation in the individual case and that cases should be individualized more than they have been in the past. The operative method should as nearly as possible fit the individual problem rather than an arbitrary or conventional rule. One wonders indeed what price, if any, in increased postoperative hazards and mutilation of tissue it is permissible to pay in order to try to gain this maybe purely academic objective of normalizing pressure without the use of "drops" unless there are specific reasons in an individual case. One should duly consider the patient's age, the prospects of life and the resistance to pressure of the tissue of the individual optic nerve or of the tissues of the particular eyeball, at the same time not forgetting to consider, as mentioned before, the necessity of reducing the pressure to the individual normal over the twenty-four hour period in those cases

in which a careful study shows the injurious effect of a nightly or early morning hypertension.

I have found that if the situation is made clear to patients in private practice the majority of them do not mind the prospect of possibly having to continue some use of miotics, to which they have already become adjusted. If they are disappointed that they may not be rid of the use of "drops" with this procedure, they are given the choice of a more radical operation if they wish. These statements do not quite hold true in the same sense in the case of clinic patients, of manual laborers, farmers or persons whose occupation makes it inpracticable to instil drops, or of those who live in regions so remote as to prevent their reporting to a specialist for periodic examination. The primary objective of the more radical operations, such as external filtering or cyclodialysis, is to normalize pressure without the use of "drops." This objective is associated with well known hazards and sequelae and in practice is often not attained. Indeed, when successful such an operation may render the use of "drops" altogether inefficacious owing to the chamber angle having become closed. This throws the whole burden on the operation, and the condition of the eye is worse than before.

## SURGICAL TREATMENT OF LATE STAGE OF SHALLOW CHAMBER TYPE OF GLAUCOMA

The procedure described in this article is not indicated in cases in the late stage in which organic adhesions of the iris have formed in the angle. The inadequacies of classic iridectomy in this stage of the disease are also well known. For this reason various modifications of it and combinations with other methods, such as in the operations of Wootton,[10] Jervey,[11] Török,[12] and the substitute operations of the external fistulating variety, trephination or iridencleisis and cyclodialysis, are usually employed in this late stage.

## SUMMARY

The procedure described in this article appears to solve the technical difficulties and dangers of operating in cases of the shallow chamber type of chronic primary glaucoma. It reduces increased intraocular pressure by restoring and maintaining the physiologic direction of out-

10. Wootton, H. W.: Cyclodialysis Combined with Iridectomy in Glaucoma Simplex: A Preliminary Report, Tr. Am. Ophth. Soc. **30**:64-70, 1932.

11. Jervey, J. W.: Scleral-Post-Iridectomy: A Rational Operation in Glaucoma; Report of a Case, Tr. Am. Ophth. Soc. **25**:160-167, 1927.

12. Török, E.: Iridectomy in Glaucoma: A New Technique, Arch. Ophth. **52**:574-581 (Nov.) 1923.

flow of aqueous. There is no cosmetic disfigurement, nor is appreciable refractive error caused. The sphincter of the pupil is preserved. It prevents postoperative adhesions in the filtration angle. It would seem to be practically free of the dangers of present day operations, such as iritis, late infection, cataract formation and other disturbing sequelae and complications. It avoids the danger of a malignant course. To judge from the limited number of cases (15) in which operation has been performed to date, it gives promise of adequately answering the purpose of an early or prophylactic operation in this type of glaucoma.

490 Post Street.

# HISTOLOGIC CHANGES IN THE LENS PRODUCED BY GALACTOSE

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In the course of a study of galactose cataract in rats by one of us,[1] chiefly from a biochemical standpoint, it seemed advisable to correlate the change in the lens seen with the ophthalmoscope and focal illumination with the histologic changes in the same lenses or with those in the lenses of animals with similar stages of opacity.

In the study of galactose cataract white rats were employed which had been placed on a diet of which galactose composed 50 per cent. All essential food factors, including vitamins, were supplied.

Lenses were removed one, three, four, six, seven, nine, fourteen, fifteen, eighteen, twenty-five and thirty-two days after feeding was begun. There were also two lenses of animals which had been placed on a normal diet after opacities had developed, to illustrate the apparent clearing of opacities which was observed in vivo. This series included lenses in which no signs of opacity were seen with the slit lamp (one and three days), those with varying degrees of partial opacity in the cortex (four to eighteen days) and two lenses described as having "early mature" and "mature cataract" (twenty-five and thirty-two days, respectively). The lenses were fixed in a solution of formaldehyde embedded in pyroxylin and stained with hematoxylin and eosin and with Mallory's connective tissue stain. For comparison with these lenses, there were available three lenses of rabbits showing opacities as a result of intoxication with naphthalene and phthalic acid and a few human cataractous lenses obtained by intracapsular extraction.

In the lenses of the rats fed galactose changes were observed illustrating increasing degrees of severity according to the duration of feeding. These changes were of similar type, but affecting areas of varying extent. The lens fibers in the affected area lost their interfibrillar membranes and changed in staining properties, the normal homogenous fibers being replaced by a granular mass of pink-staining material.

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From the Department of Ophthalmology, Northwestern University Medical School.

1. Bellows, J.: Biochemistry of the Lens: IX. Influence of Vitamin C and Sulfhydryls on the Production of Galactose Cataract, Arch. Ophth. **16**:762 (Nov.) 1936. Bellows, J., and Rosner, L.: Am. J. Ophth. **20**:1109, 1937.

In later stages this material was replaced by almost clear fluid with fine blue-staining or pink-staining granules in suspension. The nuclei near the equator showed early degenerative changes, losing their oval form as the lens fibers became liquefied and becoming round and pale or in some cases small and dark. The zone first affected was near the equator, but this was always separated from the capsule by a layer of fairly well preserved fibers with their nuclei. In the lenses of animals killed after only one day of feeding with galactose, when no changes could be observed ophthalmoscopically, no microscopic changes were found.

In the lens of the animal killed after four days, larger areas of liquefaction were seen near the equator (fig. 2), extending posteriorly to reach the posterior capsule. They extended forward in a less extensive area almost to the anterior capsule. The capsular epithelium was normal at this stage. A thin ring of opacity near the equator of the lens could be seen ophthalmoscopically (fig. 3). In the lens of the animal killed

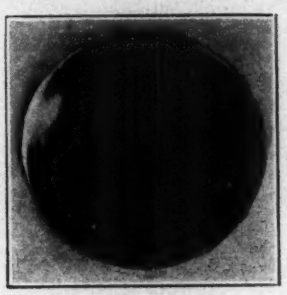

Fig. 1.—Normal rat lens; × 11.

after six days, the area of liquefaction was somewhat more extensive, while in that of the animal killed after seven days, it reached to the posterior pole. In both stages the capsular epithelium was practically normal.

In the lens of the animal killed after nine days, the area of liquefaction was much larger, occupying about three fourths of the peripheral cortex, but a thin layer of fairly well preserved fibers was left just under the capsule at the equator. In the deeper cortex just anterior to the nucleus was a small area of early fiber degeneration, but the nucleus itself was well preserved. In this stage changes in the capsular epithelium could be made out for the first time. Some of the nuclei were vacuolated, and others stained poorly. A layer of small vacuoles was present between the epithelium and the cortex. In the lens obtained after fourteen days, the area of fiber degeneration was of about the same extent as in the previous stage, but the capsule and its epithelium showed more definite changes (fig. 4). The epithelium increased in thickness from one to four cells in closely adjacent areas near the anterior pole. More

nuclei were degenerated, and the vacuoles beneath the epithelium were more extensive. The anterior capsule was wavy in contour, with fine projections where the zonular lamella had separated from the deeper layer of the capsule. In vivo the opacity at this stage was seen to involve the greater part of the anterior cortex, a clearer area, however, being left in the axial area of the lens (fig. 5). In the lens of the animal killed after fifteen days, almost all the cortex was liquefied except for a few fibers under the capsule at the equator. The capsular epithelium showed extensive changes, one area just over a cavity in the cortex being fourteen cells thick (fig. 6). Vacuoles were present in the deeper cortex just

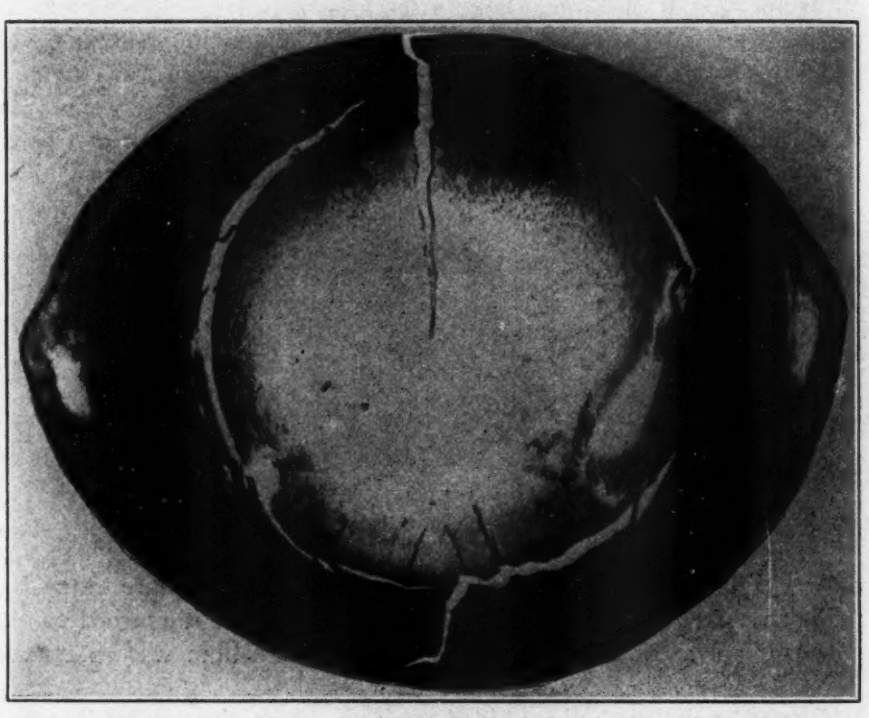

Fig. 2.—Four day galactose cataract showing an area of liquefaction in the equatorial region; × 32. The fissures around and in the nucleus are due to artefact.

adjacent to the nucleus, which, however, was apparently intact. In the lens of the animal killed after eighteen days, the changes were similar to those just described, but the area of liquefaction was not so extensive. At this and at the preceding stage the red reflex obtained was fainter, but on direct illumination the cortex did not yet appear gray.

In the lens of an animal killed after twenty-five days, the appearance in vivo was described as that of "early mature cataract." The posterior cortex was now gray by direct illumination, while the anterior cortex was less opaque. No red reflex could be obtained in the central portion

of the lens. An area of liquefaction involved most of the cortex except for a few fibers near the equator and a thin layer surrounding the nucleus. The capsular epithelium was less irregular than in the preceding stage, but the capsule showed extensive splitting of the zonular

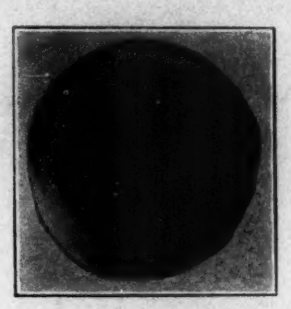

Fig. 3.—Four day galactose cataract; × 11.

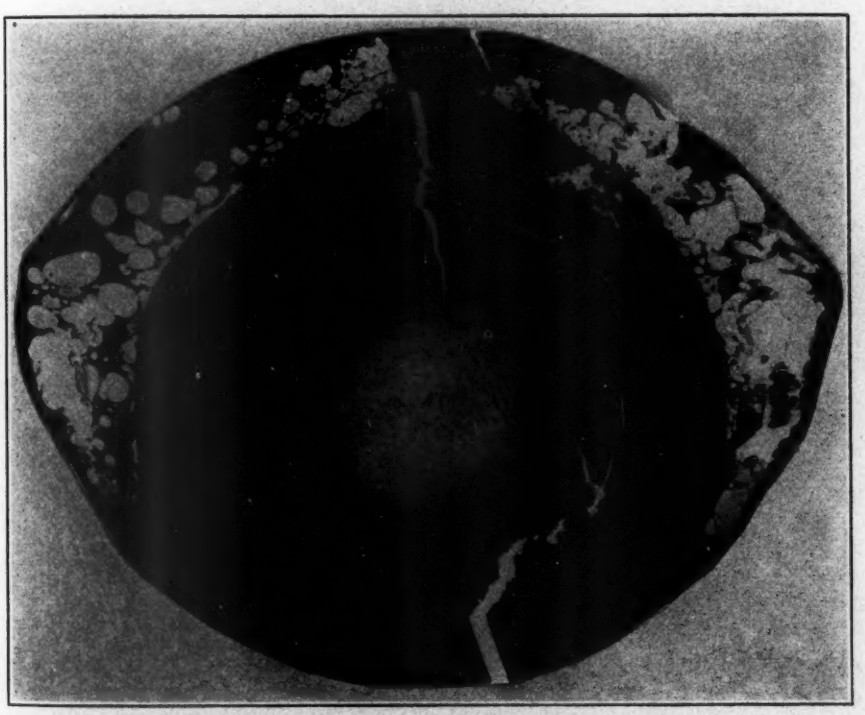

Fig. 4.—Fourteen day galactose cataract showing liquefaction of most of the peripheral cortex; × 29.

lamella. The capsule in this and the preceding stages was absent in several areas, probably representing artefact but suggesting a thinning and stretching of the capsule. In an animal fed galactose for thirty-two days the picture was that of mature cataract, the whole lens being white

and opaque. The whole cortex except for a small zone at the equator showed degenerative changes (fig. 7). Here new fibers were apparently being formed, which, owing to the extensive liquefaction, were short and curved outward to meet the capsule near their point of origin. The nuclei here were apparently normal, but the zone of nuclei, or "lens bow," was displaced back of the posterior end of the capsular epithelium. Some of the nuclei approached the posterior capsule, and a few were quite close to it. This seemed to represent the first stage in the migration of nuclei to line the posterior capsule, all previous stages having shown no nuclei posterior to the normal ending of the capsular epithelium. As is well known, in other types of cataract and in congenital anomalies of the lens, epithelium develops to form a complete lining of the posterior capsule. The deeper layers of cortex showed many cavities with only a few fibers left between them. The nucleus had fallen out in all the sections, but a thin layer of fairly well preserved fibers was left about its location. The capsule was thin, and its epithelium was irregular.

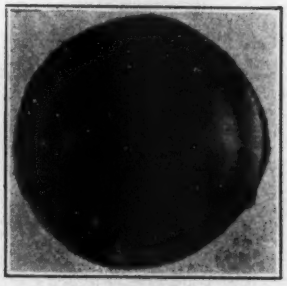

Fig. 5.—Fourteen day galactose cataract; × 11.

The animal from which sections of the four day cataract were made was placed on a normal diet after removal of one eye, and the second eye was removed fourteen days later. At this time no opacities were seen with the ophthalmoscope. However, when the eye was sectioned the remains of previously degenerated fibers just outside the nucleus in the shape of a number of cavities containing homogeneous blue-staining material were seen. Some pink-staining fragments of degenerated fibers were seen deep to these cavities between normal fibers. These areas of degeneration had been pressed toward the center of the lens by a layer of newly formed apparently normal fibers. These fibers originated from normal nuclei at the equator, which had formed a new lens bow. The layer of new fibers was most compact and thinnest at the anterior pole, where it was nine times as thick as the capsule, while at the posterior pole it was twice, and at the equator four times, the thickness of the anterior layer (fig. 8). The anterior capsular epithelium was normal.

Fig. 6.—Fifteen day galactose cataract showing localized proliferation of the capsular epithelium over a liquefied area; × 65.

Fig. 7.—Thirty-two day galactose cataract (mature stage) showing liquefaction of most of the cortex and sparing of the subcapsular zone at the equator; × 27.

The rat which provided the mature cataract described was placed on a normal diet, and the second eye was removed after fifty days. The lens showed a small central opacity with clear cortex about it. This clear zone was divided by a thin ring of partial opacity (fig. 9). Sections showed a layer of normal fibers approximately twice as thick as in the lens just described. Under this zone of new fibers was a zone containing numerous small pink-staining remains of partially degenerated fibers. Deep to this was a central area of completely disorganized

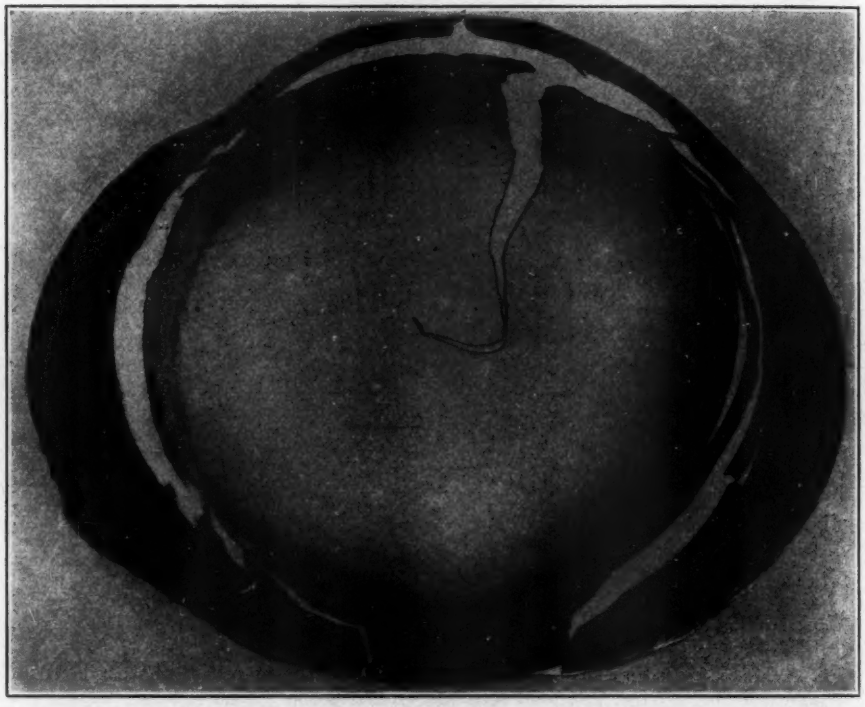

Fig. 8.—Lens of a rat fed galactose for four days followed by a normal diet for fourteen days; × 32. A layer of newly formed fibers which have pressed degenerated fibers nearer to the nucleus is apparent.

tissue (fig. 10). There were spaces containing granules and larger masses of chromatin with fragments of partially preserved fibers. There were a few double-refracting globules, evidently the myelin globules often described in human cataractous lenses. This central area represented the entire remains of the previously opaque lens, in which the nucleus had apparently undergone complete liquefaction. The capsular epithelium was somewhat irregular, and there was hyaline thickening of the capsule. No epithelium was present back of the lens bow.

In the study of naphthalene cataract the procedure described by Sallfner [2] was followed. Rabbits were fed 0.8 Gm. of phthalic acid, and five days later 2 Gm. of naphthalene in olive oil per kilogram of body weight was given by stomach tube. This was repeated on the following day. As Salffner had shown, in animals fed phthalic acid, which damages the kidneys and apparently prevents complete elimination of naphthalene, opacities of the lens developed much more promptly and regularly than in those animals fed naphthalene alone.

The chief differences between the histologic changes observed in these lenses as compared with those in galactose cataract of rats concerned the capsular epithelium and the size of the lens. After the first dose of naphthalene, the capsular epithelium was four or five cells thick. Some of the nuclei were slightly swollen, and a layer of red-staining material was present between the epithelium and the capsule. An area

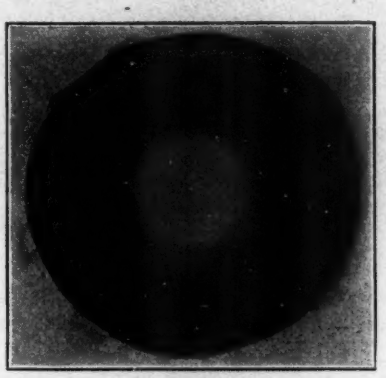

Fig. 9.—Same lens shown in figure 10; about × 25.

of swollen and degenerated fibers was present near the equator at one side, extending somewhat posteriorly. Under the posterior capsule were several "thumb-print" areas in which the fibers had lost their staining properties, only the limiting membranes being visible (fig. 11). No epithelium was present back of the lens bow. Ophthalmoscopic examination of this lens had shown a few water fissures in the peripheral cortex.

Fourteen days after the second feeding, the picture of posterior cortical cataract was present. The picture resembled that seen in human posterior saucer-shaped cataract, the anterior cortex being relatively clear. The capsular epithelium was five or six cells thick and irregular. Vacuoles and larger spaces were present between the epithelium and the cortex and also between the epithelium and the capsule. Epithelium had already migrated from the lens bow to line the posterior capsule completely. The nuclear zone of the cortex was irregular, with many

2. Salffner, O.: Arch. f. Ophth. **59**:520, 1904.

Fig. 10.—Lens of a rat fed galactose for thirty-two days until a mature cataract developed, then a normal diet for fifty days. A layer of newly formed fibers, degenerated nucleus and cortex pressed to the center of the lens is apparent.

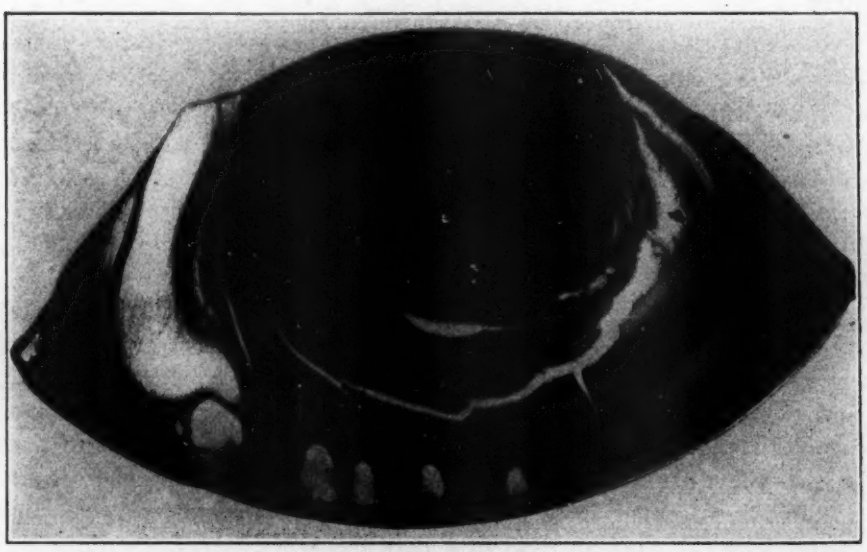

Fig. 11.—One day naphthalene cataract (rabbit) showing subcapsular areas of cortical degeneration; × 19.

degenerated nuclei. From the equator to the posterior pole was a zone of partially liquefied cortex and spaces containing clear fluid with small pink-staining and blue-staining globules in suspension. The nucleus and a surrounding layer of cortex were intact.

Twenty-seven days after the last feeding, the picture of mature cataract was present. The lens was large, being 8 by 6 mm. in its largest diameters, as compared to 6 by 3.5 mm. for the normal rabbit lens. The capsular epithelium was only one or two cells thick and completely lined the posterior capsule. The capsule was wrinkled and defective in several places. The peripheral cortex was almost completely liquefied except for a zone next to the capsule at the equator. The nucleus and a surrounding layer of cortex were apparently well preserved, though the fiber structure was less definite than in the normal nucleus.

In the human cortical cataracts available the changes were similar to those in the experimental cataracts, but with the differences to be expected in a much slower process extending over a much longer period of time. The areas of degeneration affected especially the equatorial zone, with no special sparing of fibers next to the capsule, such as was seen in the galactose cataracts. In some lenses the whole cortex was liquefied, with no normal nuclei to be seen. The capsular epithelium was irregular and lined the posterior as well as the anterior capsule.

Such changes in senile cataract are described by von Szily [3] in his exhaustive review of pathologic conditions of the lens. He also reviewed the changes in various types of experimental cataract, including that due to naphthalene, thallium and vitamin deficiencies. Salffner has provided the most complete study of naphthalene cataract. He noted especially the early changes in the capsular epithelium which were to be found from four and a half to five hours after the first feeding. They were the same as those seen in our animals, except that he observed complete disappearance of the anterior epithelium after several feedings. If feeding was stopped at this stage, the epithelium regenerated and extended also beneath the posterior capsule, as was seen in our animals. These changes were accompanied by a marked increase in the weight and volume of the lens, apparently due to absorption of water. This change was indicated in the mature cataract of our series. The swelling was formerly considered as due to increased permeability of the capsule, but since it is now known that the normal capsule is freely permeable to water, it must be ascribed to an increase in osmotic pressure of the capsular contents as a result of splitting of the lens proteins.

3. von Szily, in Henke, F., and Lubarsch, O.: Handbuch der speciellen pathologischen Anatomie, Berlin, Julius Springer, 1937, vol. 2, pt. 3.

Von Pellathy [4] described the changes in dogs with parathyroprival tetany. Changes in the capsular epithelium similar to those seen in our animals occurred, but the cortical degeneration showed an arrangement specific for this type of cataract. Layers of degenerated fibers separated by normal fibers corresponded with the occurrence of attacks of tetany separated by periods free from tetany during which normal fibers were laid down over the last layer of opacity. In the cataracts due to vitamin $B_1$ deficiency in rats, described by Day, Langston and O'Brien,[5] O'Brien [6] and Langston, Day and Cosgrove,[7] the changes resemble those in our animals with galactose cataract except that the capsule remained normal. Sections were made, as a rule, after from sixty-seven to eighty-four days of feeding. Epithelium lined the posterior capsule in the later stages. While the various stages of galactose cataract as viewed ophthalmoscopically have been described, especially by Sasaki,[8] the histologic picture has not been reported. Dodge,[9] however, has described the changes in the allied type of cataract in rats on diets containing 70 per cent of lactose, dextrin and maltose. In the animals fed lactose changes appeared in vivo which resembled those produced by galactose, but developed much more slowly. Sections showed pictures similar to those seen in our animals, except that in one preparation complete degeneration of the nucleus had occurred. Animals fed dextrin and maltose showed much slighter degrees of cortical degeneration. The various stages seen in vivo are not illustrated by sections made in sequence.

## COMMENT

It is evident that the lens, because of its freedom from blood vessels and its purely epithelial constituents, is limited in its response to various deleterious influences. It can degenerate with loss of nuclei, liquefaction of fibers and replacement of the fibers by various chemical substances. These are formed in the breaking down of the proteins or, especially in the case of calcium, are deposited in the lens after diffusion through its capsule from the ocular media. Portions of the lens can regenerate, especially the capsular epithelium and the peripheral lens fibers. Regeneration of capsular epithelium may extend to areas

4. von Pellathy, A.: Klin. Monatsbl. f. Augenh. **83**:438, 1929.

5. Day, P. L.; Langston, W. C., and O'Brien, C. S.: Am. J. Ophth. **14**: 1005, 1931.

6. O'Brien, C. S.: Experimental Cataract in Vitamin G Deficiency, Arch. Ophth. **8**:880 (Dec.) 1932.

7. Langston, W. C.; Day, P. L., and Cosgrove, K. W.: Cataract in the Albino Mouse Resulting from a Deficiency of Vitamin G ($B_2$), Arch. Ophth. **10**: 508 (Oct.) 1933.

8. Sasaki, T.: Arch. f. Ophth. **138**:351, 1938.

9. Dodge, W. M., Jr.: Histopathologic Characteristics of Nutritional Cataract in the White Rat, Arch. Ophth. **14**:922 (Dec.) 1935.

normally free of epithelium, as beneath the posterior capsule. The distribution and degree of these changes will depend in large part on the intensity with which the deleterious influence acts and the time during which it acts.

In galactose cataract the process is a rapid one as compared to that in senile cataract. Degeneration affects the young fibers near the equator, following the course of these fibers toward the posterior and the anterior poles. There is either sparing of the youngest fibers next to the capsule, or, as seems more likely, new fibers continue to be laid down from the most posterior cells of the capsular epithelium more rapidly than death of the fibers can occur. Changes in the capsular epithelium and capsule occur relatively late, and cortical changes cannot be considered as secondary to them. Growth of epithelium around the posterior capsule was just beginning in the most advanced form of cataract studied. The nucleus and a layer of cortex about it were apparently intact in all stages except the mature cataract, in which the nucleus was not present in the sections due to an artefact. The fellow eye, examined after fifty more days of life on a normal diet, showed complete degeneration of the nuclear region. This degeneration had either been present when the administration of galactose was stopped or had developed later while normal fibers were being formed at the periphery of the lens. A number of observers report early changes in the nucleus in galactose cataract, but our observations certainly indicate that the nucleus is the last part of the lens to be affected. The chemical studies of galactose cataract [10] have shown a marked loss of glutathione in the cortex in early stages while a normal amount is still present in the nucleus. In the stage of mature cataract glutathione is also lost from the nucleus. The appearance of nuclear opacity could be simulated by the increased difference in refractive index between the more compact nucleus and the cortex when this had swelled by imbibition of fluid. The formation of new fibers in the animals placed on a normal diet is interesting, since it permits lenses which were completely opaque to become clear enough for useful vision. There is no evidence that "clearing" of opacities occurs. Apparently the opaque portion, which in this case occupied almost the entire lens, is compressed by new fibers into a relatively small space in the center of the lens. This process of regeneration occurs, of course, with much greater rapidity in animals with such a short life span as the rat than in larger animals. Lenses with early opacities in rabbits with naphthalene cataract are not infrequently seen to become apparently clear, but this does not seem to occur when the whole lens has become opaque. No animals with naphthalene cataract were employed for the study of the regenerative processes in

10. Rosner, L.; Farmer, C. J., and Bellows, J.: Biochemistry of the Lens: XII. Studies on Glutathione in the Crystalline Lens, Arch. Ophth. **20**:417 (Sept.) 1938.

this series. It is well known that in man, after a limited toxic or traumatic damage to the lens, clear fibers develop at the periphery, pressing the opaque area deeper into the lens, so that the date of the damage to the lens can be approximately calculated from the thickness of new cortex over the opacity.

In naphthalene cataract, especially when phthalic acid has also been employed, the process is even more rapid in onset than in galactose cataract. The capsular epithelium is damaged early and for some reason, possibly because of the species of animal employed, the posterior capsule becomes lined with epithelium early. It is probably not because of this damage to the capsule but because of simultaneous damage to the lens fibers and their nuclei, with breaking down of lens protein, that swelling of the lens by imbibition of fluid is more marked than in galactose cataract.

In senile cortical cataract the differences are attributable to the much greater time during which changes occur, the slower growth of the lens and the greater age of the lens when the degenerative process begins. At this age the nucleus is large and compact and usually shows beginning sclerosis, a process which is never seen in the forms of experimental cataract studied. Extensive deposits of calcium and lipoid material which are seen in senile cataract require a considerable time for their occurrence and were not seen in our experimental cataracts, except for a few "myelin" droplets in one animal killed fifty days after mature galactose cataract had developed. Little or no development of new normal fibers at the equator was observed, the zone of degeneration remaining, as a rule, close to the capsule. The tendency of capsular epithelium to line the posterior capsule was seen in most lenses studied, as in the naphthalene cataracts.

## SUMMARY

Lenses showing various stages of galactose cataract were sectioned, and the histologic changes are described in sequence.

A less complete series of lenses with naphthalene cataract and a few lenses with senile cataract were studied for comparison.

Histologic changes were found in lenses which appeared normal in vivo. (Examination with the slit lamp was not employed routinely.)

In galactose cataract the earliest changes involved the cortical fibers near the equator, but growth of new fibers was rapid enough so that some relatively normal fibers were always found just beneath the capsule in this region. The capsular epithelium showed changes later. The nucleus remained undamaged to a late stage. Regeneration of new fibers occurred rapidly when a normal diet was resumed.

In naphthalene cataract the capsular epithelium and peripheral cortex were involved simultaneously. Rapid swelling of the lens occurred. The nucleus remained intact to a late stage.

# Clinical Notes

## ANTERIOR CHAMBER IRRIGATOR

PARKER HEATH, M.D., DETROIT

An anterior chamber irrigator should be simple in design and easy to clean and to manipulate. Its supply of solution should be visible at all times, and it should have a volume of not less than 10 cc. It should be made of nonsoluble, boilable material, free from any tendency to cast off particles, such as rubber. The tip should be easily and securely fixed in place. The instrument pictured approaches these qualifications.

It is used with one-half strength physiologic solution of sodium chloride or the more complicated Ringer's solution. The solution must be carefully prepared, filtered three times and fractionally sterilized.

Anterior Chamber Irrigator.

Two of these instruments are prepared as a precaution against refilling during the operation.

Besides its use for irrigating the anterior chamber, this instrument may be used as a further precaution against infection to wash the limbus or area of puncture before corneal section in cataract extraction, needling or a keratome incision.

## CASTS OF THE HUMAN EYE FOR CONTACT LENSES

S. MAISLER, M.D., SAN FRANCISCO

For the past year I have been using a new impression material for the making of molds of the human eye. Molds have been made in the past (Stevens [1] and Obrig [2]) with the plastic material negocoll. But the time element (two minutes, shortest approximate time) for the

1. Stevens, C. L.: A Method for Making Casts of the Human Cornea, Am. J. Ophth. **19**:593 (July) 1936.

2. Obrig, T. E.: Fitting of Contact Lenses for Persons with Ametropia, Arch. Ophth. **17**:1087 (June) 1937.

gel to set on the eye works some hardship on the patient, it being difficult to keep the eyes fixed in one position for any length of time.

In order to obtain a fast setting gel, I sought the assistance of J. J. Jansen, D.D.S., of San Francisco, who about a year ago was developing a reversible hydrocolloid gel. After some modifications in the density and consistency of his original preparation, successful molds were made in one minute or less. This elastic impression material is now known as Kerr's hydrocolloid and is manufactured by the Detroit Dental Manufacturing Company. To facilitate handling, it is dispensed in collapsible tubes similar to tooth paste. The entire tube of colloid can be softened by submersion in a hot water bath and, while soft, can be kneaded in the tube itself. The workable

Fig. 1.—First three casts, made from eyes with high myopia; second three casts, made from eyes with keratoconus.

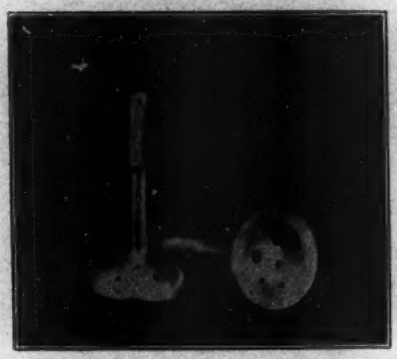

Fig. 2.—Silver molding shells.

temperature of the plastic is in the range of from 100 to 104 F. It affords a smooth impression surface, has good elasticity and holds its body. The hydrocolloid will not adhere to the casting material.

For casting, a French dental plaster or artificial stone is employed (fig. 1). The casting should be done soon after the mold is obtained, because, as is common with all hydrocolloids, some shrinkage may take place if the mold is exposed to air too long. It is always wiser to make more than one mold; however, should this not be feasible, a negative impression can be made as a duplicate from the original casting.

The molding shells made of glass, as originally illustrated by Obrig,[3] were fragile and would not tolerate sudden changes in tempera-

3. Obrig, T. E.: Molded Contact Lenses, Arch. Ophth. **19**:735 (May) 1938.

ture. I therefore utilized very thin silver shells [4] (fig. 2). These can be made of varying thicknesses—some so thin as to be malleable and adjustable in circumference contour. In order to obtain a better fixation between the gel and the molding shell, it has been found advantageous to have multiple perforations in the body of the shell so that the gel may anchor itself. Pressing some of the gell up into the hollow handle before inversion onto the eyeball also allows for easier removal after solidification. It is possible to obtain a hard gel within a minute's time by flushing the highly conductible silver shell with ice water from an undine.

Other modifications in technic include the use of a suction tube on the hollow handle to facilitate removal of the mold from the eye. A double chambered shell and handle with an upper inlet and lower outlet for quick cooling with ice water can be used, but it is slightly cumbersome.

SUMMARY

A new gel known as Kerr's hydrocolloid has been used for the past year in the making of molds of the human eye. The need for a quick solidifying gel of good body and elasticity has been fulfilled. To enhance the rapid setting or chilling of the gel, silver molding shells of a new design have been utilized.

350 Post Street.

4. These shells are obtainable from Trainer and Parsons, San Francisco.

# Ophthalmologic Reviews

## ENTITY OF MUSCLE RECESSION

### A SHORT RÉSUMÉ OF ITS TECHNIC AND PRINCIPLES WITH NEW SUPPLEMENTARY NOTES AND ILLUSTRATIONS

P. CHALMERS JAMESON, M.D.
BROOKLYN

In 1922 I [1] published the results of over five years' work, the object of which had been to impart the requisites of definite broad scleral fixation and definite gradation to the side (tenotomy) where these safeguards had not, to any great extent, been previously applied. In this paper were reported the first 50 cases in which single recession was performed under these accurate safeguards and the somewhat revolutionary knowledge obtained therefrom.

The single study demonstrated among other things the following facts:

1. The highly energized muscles (i. e., the convergent muscles) are more sensitive to surgical intervention than the other muscles, thus necessitating conservation in gradation. This fact is, on the other hand, offset, because a moderate amount of recession gives a much higher contribution to correction by these highly innervated muscles than the same amount of recession would on the other side, i. e., the passive, advancement side.

2. There is great value in being able to fix sclerally with accuracy and to grade and compute sclerally on both sides, attributes which were previously only the property of advancement.

3. A combined procedure unnecessarily performed sometimes annuls the effect of both the recession and the advancement. Unless ruled out by computation, an equal proportion in the average case is 1 mm. of recession to 2 mm. of advancement.

4. The great value of computation and of typing the deviation before operation with a view to imparting the best selected operative procedure and gradation cannot be overestimated.

5. The necessity of exposing the field of operation and thoroughly inspecting the anatomic structure, muscularization and fascial tension is equally important.

1. Jameson, P. C.: Correction of Squint by Muscle Recession with Scleral Suturing, Arch. Ophth. **51**:421 (Sept.) 1922.

On the basis of these facts I have evolved the principles of the entity of recession and its intimate but contrasting relation to advancement. These principles have greatly enhanced the value of the surgeon's approach in the selection of an operative technic. This applies both to advancement and to recession.

## TECHNIC OF OPERATION

The technic is presented in figure 1. I find the adoption of the through and through operation (i. e., the carrying of the individual sutures continuously through so that the ultimate tie brings all tissue into one position) as a routine the most expedient method. I do not always follow this, for sometimes I suture the muscle independently to the sclera first, closing the conjunctiva separately.

If one does not make a liberal flap of conjunctiva, covering the field of operation, the foregoing step, i. e., separate suturing of the muscle and the conjunctiva, had better be practiced.

After many preliminary trials, I am sure that the primary incision at the semilunar fold is the best procedure and has great advantage, although one is likely to hark back to the usual incision at the insertion of the muscle. The incision at the usual place over the insertion has a disadvantage in recession as it necessitates the burying and absorption of the suture and, what is still more important, does not bring the muscle end to the primary incision to the point to which the muscle is recessed. The reaction is greater, drainage is not as free and, as mentioned previously, the suture material must be absorbed. Some objection has been made at different times to the free lateral diverging incisions. These incisions are the most desirable manner of recessing or advancing a muscle. Reference to figure 1, *IV*, will explain the mechanism.

*Suture Arrangement.*—Broad, well spread, properly placed, secure attachment is necessary. The central suture should be looped above and below, as illustrated in figure, 1, *V*, or the ligated suture should be used if the through and through method is not practiced.[2] This is advisable if tension is high.

*Technic of Scleral Suturing.*—Scleral suturing in the region of the equator, hitherto considered difficult, dangerous or impossible, has been made definitely an easy and innocuous procedure. The technic is based on the translucency of a thin lamella of sclera fiber, so that a needle or suture passed under such a lamella is always visible. Contrawise, a needle or suture passed through the entire thickness is invisible, as in a case of perforation. It is necessary only to direct the point of the

2. Jameson, P. C.: Ligated Suture, Arch. Ophth. **12**:377 (Sept.) 1934.

needle, carefully keeping it visible. Details of this technic have already been published.[3]

### INSTRUMENTATION

The instruments I use are shown in figure 2. The bullet-headed strabismus hook has a bend in the shank for the reception of the muscle.

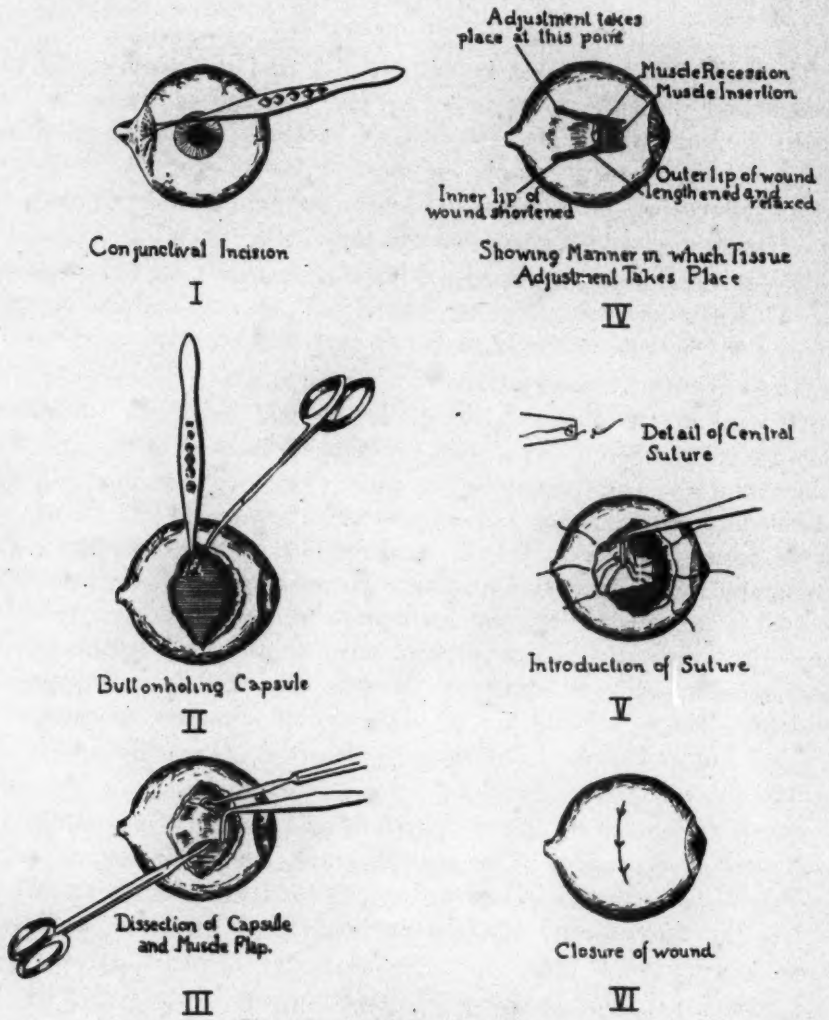


Fig. 1.—Technic of operation.

The rounded, rather bullet-headed hook is inserted into the buttonhole of the capsule and makes its way without trauma, appearing large where the counteropening in the capsule is made. The Noyes forceps which I use has been slightly modified, the lower blade being lined with

3. Jameson, P. C.: The Surgical Entity of Muscle Recession, Arch. Ophth. 6:329 (Sept.) 1931.

an insertion of copper which prevents the needle from twisting or turning. This is used in the French forceps. The muscle forceps is made on the spike and inlet principle and has a 10 mm. rule on the side. A muscle cannot retract between the blades. The needles (fig. 3) serve their purpose of gliding through the scleral fiber without obstruction.

### SUTURE MATERIAL

I use for the most part ten day, 000 chromicized catgut. Catgut has many advantages for muscle work. I use it for advancement, resection and recession. Catgut of 000 caliber has a strength equal to the requirements of any operation on the muscles. A catgut of lesser caliber may be used if the tension is not too high. Catgut is less irritative and strangulates less than silk; it also cuts through less if subjected to tension. It irritates less the longer it is retained—a con-

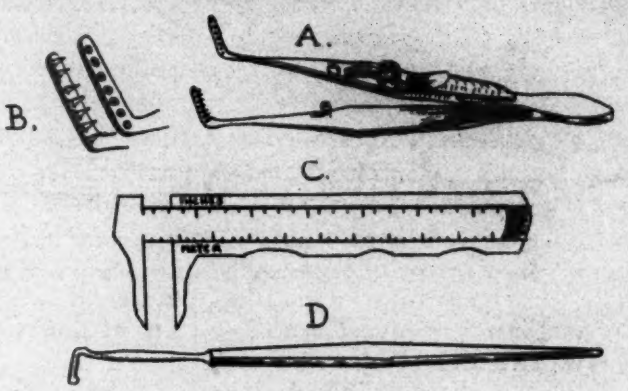


Fig. 2.—Instrument used for operation: *A*, recession muscle forceps; *B*, detail of teeth; *C*, caliper, and *D*, strabismus hook.

trast to the property of nondisintegrating sutures. It does not require removal, and there is no occurrence of stitch abscess or digging for sutures, a great advantage for nervous children. Granulation, sometimes stated as an objection, has not been more noticeable than with other sutures.

### COMPUTATION

From the fact that formerly it was possible only to grade and fix sclerally the muscle on one side and that now it can be graded and fixed sclerally on both sides, certain fundamental principles, hitherto undemonstrated, have come to light, some of which I have already mentioned. These principles cannot be overlooked if one is to apply the operative plan which is best adapted to the correction of the deviation.

Prior to the advent of recession, operations on the ocular muscles were stereotyped. The most popular method was and is in some instances today advancement on the nondeviating side and "cut until effect is obtained" on the deviating side. This method is attractive because it is so easy, but the lesson which recession has taught is that the highest return of correction is not attained in this way but by first

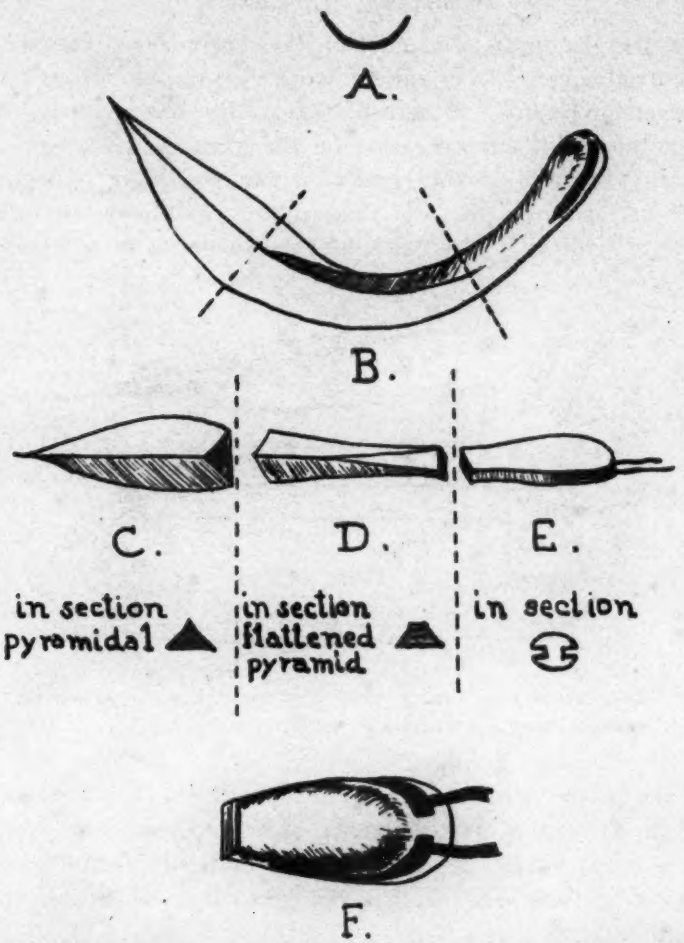


Fig. 3.—Needle used for operation. In *A* it is three-fourths actual size, actual measurements being 14 mm. from the eye to the butt. *B* is an enlarged view of the needle. *C* shows the forward part of the needle with a javelin-shaped rutting blade; *D*, the central part of the needle, with a flat saddle to prevent turning in the holder, and *E*, the needle butt ingrooved in the side. In *F* are shown the details of the ingrooved butt, end view.

typing the deviation and ascertaining the muscular, tensive, anatomic and innervational conditions underlying it and then applying the operative procedure best adapted to its correction.

The operator who does recession has had ample demonstration that advancement is not indicated in every case, that recession may be contraindicated in certain cases and that a combination of advancement and recession, although sometimes markedly indicated, may destabilize the corrective accomplishment of both if used improperly.

How than shall one make a computation of which should be done and of how much should be done? As already stated, the decision will be based on conditions underlying the deviation and largely on the question as to whether hypermuscularization, hypertension or hyperinnervation exist and to what extent they exist or are absent.

There are, I believe, four valuable means for determining esotropia: (1) determination of the near point of convergence, (2) measurement of the relative prism degree for distance and near points, (3) excursion tests and (4) anatomic examination. The first and second methods were originally developed by Alexander Duane and emphasized by his associate James W. White [4] in his teachings. To these I have added the making of excursion tests as important. In the early work on recession I had noticed that an external rectus muscle opposed by a highly muscularized internal rectus muscle was frequently incapable of abducting to the caruncle. When, however, the internal rectus muscle was reduced in strength and placed further back on the globe, the external rectus muscle would abduct freely. I have also introduced actual anatomic findings after exposure at the time of operation. The value of this cannot be overemphasized. Amplification of these methods will be found in my previous writings.[5]

These tests are, of course, designed to convey the underlying conditions of the deviation, as follows:

1. If the near point of a convergent deviation is normal or better than normal (i. e., 50 mm.), hypertension is likely to exist on the deviating side.

2. If the prism degree measurement is in excess for the near point above that for distance, hypertension will most likely be found.

3. If the excursions are vigorous on the inside, faltering slightly on the outside, hypertension would be indicated.

4. When high muscularization, fascial contraction and resistance to the strabismus hook are found after exposure, they corroborate the foregoing findings of hypertension. If these are found, recession is probably indicated. If after testing the patient one finds (*a*) the near

4. White, J. W.: Routine Muscle Examination in Its Practical Application, Tr. Sect. Ophth., A. M. A., 1934, p. 160.

5. Jameson, P. C.: Some Essentials and Securities Which Stabilize Operations on Ocular Muscles, Arch. Ophth. 8:654 (Nov.) 1932; footnote 3.

point remote (much over 50 mm.), (*b*) the prism measurement greater for distance than for the near point, (*c*) the excursion of the deviating muscles feeble and (*d*) attenuation and laxity on exposure, hypertension is not likely to exist on the deviating internal rectus muscle. Not every deviating internal rectus muscle has a strong, tense, highly muscularized system. One should never consider recession of a weak deviating internal rectus muscle; for such a muscle emphasis should be placed on the advancement, single or bilateral. The determination of the near point of convergence is a most valuable test. It must not be confused with fusion tests. Synchronous convergence can be elicited in a great majority of cases, even in amblyopic eyes, by the employment of a white or black knobbed pin or a 3 mm. black spot on a white card. After asking the patient to fix, the pin or spot can be made to approach the eye, and the point at which the converging muscle falters and the eye swings outward can be recorded as the acme of convergence.

Recession can nearly always be used conservatively in cases of esotropia associated with high tension, and in most instances esotropia is of the high tension type. On the other hand, advancement is indicated when high tension does not exist, as in the instance when a remote convergence point exists..

Advancement in cases of extropia should, in most instances, be performed on the internal rectus muscle if the squint is of the convergence insufficiency type. If the squint, however, is of the divergence excess type, a good correction can sometimes be obtained by recession on the external rectus muscle. The reason for this is that the internal rectus muscles have not greatly impaired convergence power and that after recession they function actively. The convergence point is as a rule better in this type of case than would be expected in a case of external deviation.

The fact should not be lost sight of that recession will give the highest return of correction when high tension, high muscularization and innervation exist. Advancement will give an adequate return of correction when unopposed by the foregoing factors and should always be the operation of choice in such instances. Advancement and recession can be used to great advantage together, but one or the other unnecessarily performed will sometimes demoralize the return of correction from both. Again, while recession is much more limited in the amount which can be done in comparison to advancement, it yields far the higher contribution to correction, especially in cases of esotropia, but should be used more conservatively than advancement. A good average is the proportion of 1 mm. of recession to 2 mm. of advancement.

GRADATION

In estimating gradation in a given case, recession is restricted to certain limits. It is generally conceded that the limit to which a muscle can be recessed is the equator. There are exceptions to this principle, as for example, the retraction syndrome, strabismus fixus and giant muscle types. Reference to figure 4 will show the area in millimeters to which a muscle can be recessed. As the muscles differ in their insertion, the recessed areas must differ. The internal rectus muscle has the greater area of recession and the superior rectus muscle, the lesser. The diagram is ultraconservative. In the instance of a large

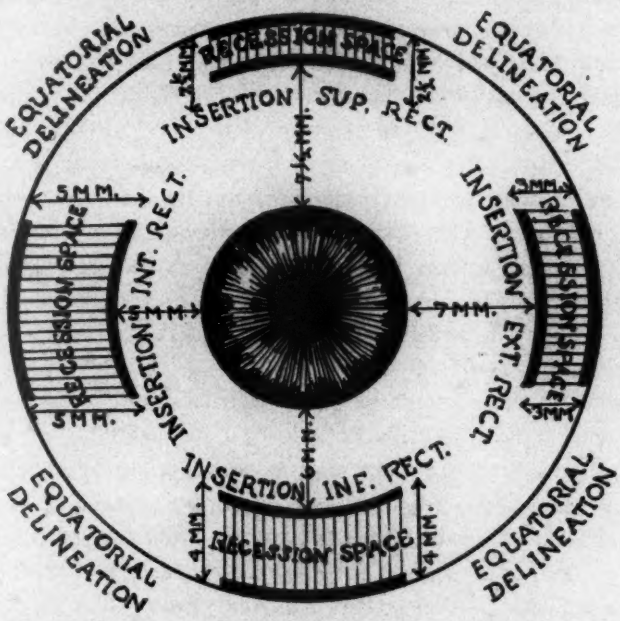


Fig. 4.—Diagram demonstrating the area in millimeters to which a muscle can be recessed.

eyeball, from 1.5 to 2 mm. can be added to the recession spaces. Priestley Smith's rule that the diameter of a cornea of 11 mm. gives indication that the eye is normal in size is a good guide.

While advancement and resection can be greatly exceeded in comparison to recession, their contribution to correction is much less than that obtained by recession. This should be borne in mind, and, as stated previously, it gives rise to a rule which I have established for myself, i. e., 2 mm. of advancement to 1 mm. of recession.

Deviation should never be the only guide to gradation. It should, however, be taken as one of the guides. The tables which attribute so many degrees of correction to tenotomy or advancement are not reliable

in the individual case except when taken in conjunction with the underlying condition of the deviation just mentioned. The proof of this statement is to be found in the different estimates and amounts obtained. A bilateral advancement mentioned as giving 35 degrees of correction may give no correction if opposed by high muscularization, tension, hyperinnervation or fascial obstruction. A recession of 5 mm. may correct 25 degrees of internal deviation if tensive conditions exist; it may overcorrect an internal deviation of as many degrees if the near point of convergence is remote.

But if one does not rely wholly on deviation as to the indication for gradation or if one is not guided wholly by stereotyped tables, it is natural to ask: What can one go by? My own answer to this question is: Type the deviation and have a clear understanding as to conditions of hypermuscularization and hypertension underlying and opposing the deviation and other conditions existing. Corroborate this understanding by direct inspection after exposure of the anatomic structure. Select the operation, advancement, resection, recession or combined operation, as indicated. Have the extreme limits of recession or advancement in mind and place the suture and muscle ends at the points indicated by the computation. This may be the extreme, the moderate or very moderate number of millimeters. After a little experience the result will be strikingly accurate.

In estimating the amount of gradation, it should always be remembered that one should lean to the side of conservatism. It is bettter to leave a slight convergence than to run the risk of overcorrection. In all types of operations, advancement or recession, single or combined, there will remain an erratic return of noncorrection. Recession can be no exception, and the reasons for the overcorrections obtained with its early use were that conservatism was not observed and careful computation as to how much and what should be done was not practiced. As has been already remarked, the converging system is much more sensitive to surgical intervention and millimeter for millimeter gives a much greater return of correction than does advancement.

There is no doubt that the entity of recession contributes largely to an increased return of correction, if properly, that is, conservatively, performed, and if it is practiced not only as an operation but as an entity, it stabilizes operations on both the advanced and the recessed side.

# Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

## Anatomy and Embryology

THE NERVES OF THE CILIARY BODY IN MAN. H. KRUEMMEL, Arch. f. Ophth. 138: 845 (July) 1938.

The eyes of a person executed by decapitation became available for anatomic examination. Immediately after the execution saline solution was injected into the carotid arteries to make the head anemic. The saline solution was followed by fixation with a solution of formaldehyde. Flat (tangential) sections of the ciliary body were treated after the silver impregnation method of Bielschowsky and Gros. The results are presented in excellent drawings made with the help of the Abbe drawing apparatus. "These drawings show the structure of the nerves of the ciliary body better than the most comprehensive description."

P. C. KRONFELD.

## Color Sense

STUDY OF DISTURBANCES OF COLOR VISION WITH NAGEL'S ANOMALOSCOPE. A. Y. SAMOYLOV, Vestnik oftal. 11: 477, 1937.

This thorough and interesting article lends itself to abstracting with difficulty. The importance of exact methods for examination of the color sense is discussed because of the tremendous progress in industry and aviation. Samoylov studied disturbances of color sense in Freiburg and has used the anomaloscope for the past decade on several thousand patients. The technic of the use of the instrument (second model with a freely movable ocular) is given in detail and is illustrated by several drawings. On the basis of his vast experience, Samoylov believes that the anomaloscope gives the most exact test of color sense, only it must be used in a certain order and system, otherwise the data may be contradictory and not correct. The advantage of testing color sense with the anomaloscope lies in the possibility of making a quantitative analysis of the various shades of colors, of the disturbance of separate forms of color vision which are mixed up by the subject and also of color asthenopia. The author discusses in detail the technic of establishing the quantitative characteristic of the relative illuminosity of each of the three monochromatic spectral tones which participate in the formation of the equation.

Color asthenopia and its examination has been worked out by Samoylov by using the method of "the amplitude" of color equations which are made by the subject on the anomaloscope. Since color asthenopia often occurs because of general fatigue without visual strain, Samoylov is inclined to think that its effect can be attributed to the central nervous system. Many methods are still in the stage of experi-

mentation and many points in color blindness are not clear as yet; still there are wide possibilities open with the wider use of the anomaloscope which undoubtedly will aid in the study of certain angles of disturbances of color sense.

O. SITCHEVSKA.

## Congenital Anomalies

FAMILIAL CONGENITAL UNILATERAL MELANOSIS. A. PAVIA, Arch. de. oftal. de Buenos Aires 13: 8 (Jan.) 1938.

A case is reported of benign, congenital, nonprogressive melanosis of one eye, with invasion of the skin of the lids, bulbar conjunctiva and iris, in a man 27 years of age. A female cousin also had a congenital pigmentary lesion in the left eye which extended to the skin of the lids and the forehead.

C. E. FINLAY.

## Conjunctiva

ROLE OF MILDEW FUNGI IN THE COURSE OF OCULAR DISEASES. A. FAZAKAS, Klin. Monatsbl. f. Augenh. 100: 434 (March) 1938.

Fazakas cultured eighteen species of mildew fungi in nearly 26 per cent of 456 healthy eyes. Most of these species may assume a pathologic nature at times. About 37 per cent of pathologic eyes harbored mildew fungi in the conjunctival sac, on the palpebral margin and in the lacrimal passages. They may influence the character of ocular diseases or prolong their course. They may render diagnosis difficult, for instance, in corneal infiltrations, in pannus and in dentritic herpes of the cornea. The report contains notes on eczema, on "keratomycosis periconica," the causative fungus of which Fazakas succeeded in isolating, and on some other forms of infections, caused by Sporotrichum and Aspergillus.

K. L. STOLL.

## General

EXPERIENCES WITH CONTACT GLASSES. C. H. SATTLER, Klin. Monatsbl. f. Augenh. 100: 172 (Feb.) 1938.

None of the more than 200 patients fitted with contact glasses by Sattler showed a permanent lesion of the eyes. Folds in Descemet's membrane in myopic eyes, caused by pressure, and a haze of the corneal surface were transient symptoms; fine veils of the corneal epithelium disappeared as soon as the contact glass was removed. Contact glasses with a radius of from 7.5 to 8.5 mm. were tolerated better than those with a larger or smaller radius. Myopic persons who were unable to wear comfortably afocal contact glasses with a radius of from 9 to 10 mm. had no difficulty in wearing those with a corneal radius of 8 mm. on which the required concave effect was ground. Shells (contact glasses) with a diameter of 22 mm. were borne with more ease than those with a diameter of 20 mm. because the pressure was distributed over a larger surface of the conjunctiva. The heptic radius of 12 mm. usually was the best (74 times in 96 patients fitted with Zeiss contact

glasses). Sattler's youngest patient was a boy aged 11 years who was fitted with contact glasses after removal of a traumatic cataract. Two thirds of his patients were myopic, and 16 patients had aphakia, 10 of whom had fair vision in the eye which was not operated on and good depth vision. Hyperopia was corrected with contact glasses in only 6 patients. Permanent recovery from recurrent corneal ulcers was obtained with contact glasses in 3 patients. One of these patients had been subject to keratitis resembling that complicating rosacea caused by flour dust. Most patients were able to tolerate Zeiss contact glasses during the entire day. Some of them removed the shell at noon; others wore a shell alternatingly in each eye. One patient wore the shell for forty hours; others forgot to remove them during the night, without ill effect. A veil in the corneal epithelium, causing halos around lights, was provoked often by a stationary air bubble. Ringer's solution is preferable to saline solution.

Twenty-four patients with a high degree of astigmatism were unable to wear the Zeiss shells because they pressed on the axial portion of the cornea. Some of these patients were fitted with shells made by Müller-Welt, Müller (Wiesbaden) or by the Dallos method after a moulage had been made by the author. He considers the Dallos method theoretically the best, but practically difficult. The Zeiss shells move better with the eyeball than the other types, but the Müller-Welt shells may be inserted and removed more readily. Advantages were experienced in amblyopic patients who were given the Müller (Wiesbaden) shells with high concave action and additional spectacles with a convex lens.

K. L. Stoll.

## General Diseases

Osteitis Deformans with Pigmented Corneal Degeneration
R. von der Heydt, Am. J. Ophth. **20:** 1139 (Nov.) 1937.

Von der Heydt reports the case of a man aged 57, who presented a bilateral corneal condition. Each cornea showed a horizontally oval area covering about one half of the middle portion which was fairly well circumscribed, opaque and the color of milk chocolate. The surface was covered by epithelium. The clouding was most intense at the level of Bowman's membrane and gradually lessened as it went deeper. There were fractures and short cracks in the membrane as well as round clear foramens. The patient had had numerous fractures of various bones. A diagnosis of osteitis deformans was confirmed by roentgen examination.

W. S. Reese.

Bilateral Aneurysm of the Internal Carotid Arteries.
A. Bozzolli, Riv. oto-neuro-oftal. **14:** 304 (May-June) 1937.

Bozzolli discusses a case of bilateral aneurysm of the internal carotid arteries in which he was able to follow the course from the first observation to necropsy. All ocular and roentgenographic signs of a sellar tumor were present throughont life, and in the late stages the patient showed an early acromegalic syndrome.

Bozzolli comments that clinically the diagnosis is only presumptive, as usually no roentgenographic evidence of the dilatation of the vessels or of the presence of plaques can be obtained. He feels that there is no symptom or sign which will distinguish this disease from disease of the sellar region except in the occasional case in which there is roentgenographic evidence of the vascular changes in the carotid arteries.

F. P. GUIDA.

## Injuries

POWERFUL ELECTROMAGNET WITH AUTOMATIC MOVEMENT, MOUNTED ON A MOVABLE TABLE, TO BE USED IN OPHTHALMOLOGY AND SURGERY: MODE OF USE. G. NECHITCH, Ann. d'ocul. **175:** 507 (July) 1938.

In former publications in the *Annales d'oculistique* the author reported the results of his experimental work in the construction of a large electromagnet and its application in ophthalmology and surgery. This was the strongest magnet known up to that time, and it was shown that it could be used with precision and automatically with the aid of two electromotors. The electromagnet described in this article resembles the previous one to a certain degree. It has been improved by being made in the form of a cone, which renders it easier to use. It also permits a larger view of the operative field and allows more space for movement.

There are five drawings depicting the magnet in detail and three illustrations. Illustrative cases are reported demonstrating the use and application of the magnet for removal of magnetic foreign bodies from the eye. Extraction of magnetic fragments from other parts of the body is also considered.

S. H. MCKEE.

## Lacrimal Apparatus

LATERAL INSERTION OF THE NASOLACRIMAL CANAL INTO THE LACRIMAL SAC. C. DEJEAN and J. PORTAL, Bull. Soc. d'opht. de Paris **50:** 195 (May) 1938.

An unusual relation of the lacrimal sac and the nasolacrimal duct was verified by the injection of iodized poppyseed oil. A Bowman probe introduced in the lower canaliculus of either side entered the sac well but would pass no farther. The iodized oil came through to the nasal cavity. A roentgenogram shows that the canal entered from the side instead of being in the axis of the lacrimal sac.

L. L. MAYER.

THE ASCORBIC ACID CONTENT OF TEARS, SALIVA AND SERUM. G. COLOMBO, Ann. di ottal. e clin. ocul. **66:** 142 (Feb.) 1938.

Estimations were made on the fluids of 4 normal persons, 4 persons with keratoconjunctivitis and 8 with trachoma. The technic of obtaining and examining the fluids is given in detail. The average amount of

ascorbic acid in the tears of the normal persons was 5.739 mg. per hundred cubic centimeters; in the saliva, 2.649 mg., and in the serum, 5.040 mg. Individual variations were slight. The average amount in the tears of the patients with keratoconjunctivitis was 5.818 mg. per hundred cubic centimeters, while that in the tears of the patients with trachoma was 6.198 mg. The slight increase in conditions accompanied by increased lacrimation is believed to be of no great significance. The slightly greater amount in the tears as compared with that in the serum is attributed to technical factors in the determinations, the ascorbic acid in the tears being, without doubt, derived from that in the blood.

S. R. GIFFORD.

## Lens

TOTAL LIPIDS OF HUMAN CATARACTOUS AND SCLEROSED LENSES. P. W. SALIT, Am. J. Ophth. 20: 157 (Feb.) 1937.

Salit found that cataract and pathologic sclerosis are more or less related and that total lipids of both mature cataracts and highly sclerosed lenses are slightly higher than those of practically normal lenses. Both cataractous and sclerosed lenses increase in weight up to the last stages, whereupon there is a marked and abrupt decrease in weight. This indicates that the increase in weight in the lenses of both types is chiefly due to absorption of water and that the sudden decrease in weight is produced by diffusion of the dissolved lens substance into the aqueous and vitreous at the height of intumescence. The total lipids of senile human cataractous lenses are made up of phospholipids, cholesterol and unclassified lipids or fat in approximately equal amounts; the ratio between the phospholipids and the fat decreases with the development of the cataract; the phospholipids decrease and the fat increases as the cataracts approach maturity. To a lesser degree this is true also of the cholesterol-fat ratio, but here the cholesterol remains practically the same, and the diminution in ratio is chiefly due to increase in fat.

W. S. REESE.

STUDIES ON GALACTOSE CATARACT. J. G. BELLOWS and L. ROSNER, Am. J. Ophth. 20: 1109 (Nov.) 1937.

Bellows and Rosner give the following summary:

"A galactose diet causes a loss of glutathione in the crystalline lens of rats, this loss preceding the lens opacities. A similar decrease of the glutathione concentration in the lens occurs in the guinea pig and rabbit placed on a galactose diet. Since glutathione is diminished in the senile lens and decreased or absent in all forms of cataract, this loss is significant. Another parallel that can be drawn between senility and the effect of galactose on the lens is a rise in the potential that takes place in both conditions. Cystine and vitamin C exert a retarding influence upon the onset and progress of galactose cataract. Scurvy in itself causes an increase in the glutathione concentration in the lens of the guinea pig, whereas when superimposed upon a high galactose diet, there occurs a greater loss of glutathione than that produced by a galactose diet alone."

W. S. REESE.

SOME TECHNICAL QUESTIONS IN CATARACT SURGERY. W. F. MONCREIFF, Am. J. Ophth. **20**: 1245 (Dec.) 1937.

Following a discussion of various operations for cataract, Moncreiff gives the following summary and conclusions:

"For securing the ideal result in cataract surgery, comprising maximal vision, preservation of the anatomical integrity of the eye as fully as possible, and for the prevention of several important complications, the following procedures have been found to be of great value: Ciliary-ganglion injection, corneoscleral suture, lens extraction without iridectomy, and, for the extracapsular technique, capsulectomy and adequate irrigation of the anterior chamber.

"It has been observed that total iridectomy is practically a routine in cataract surgery with some operators, and is employed by many others with greater frequency than is necessary. It is believed that without firm closure of the wound, many patients are subjected to added risks of complications in wound healing that are in most cases eliminated by the corneoscleral suture. In a large proportion of cases, lens extraction can be safely accomplished without iridectomy, thus enhancing both visual and cosmetic results, by accurate preliminary dilatation of the pupil and by firm wound closure with the corneoscleral suture."

W. S. REESE.

OXIDATION-REDUCTION BUFFER POWER OF LENS FOLLOWING ACTION BY ASCORBINASE. J. NORDMANN and H. VERTRUYEN, Compt. rend. Soc. de biol. **128**: 410, 1938.

The normal lens has a characteristic oxidation-reduction buffer power of from 120 to 165 millivolts, which disappears in the lens with senile cataract. Vitamin C is the only substance in the lens which has its oxidation-reduction potential in the same zone. Since ascorbinase destroys vitamin C, it is significant that ascorbinase added to triturated fresh bovine lens destroys its oxidation-reduction potential; in a control experiment a normal result was obtained with boiled ascorbinase. Accordingly, it seems that the oxidation-reduction buffer power of the normal lens is due to its vitamin C content.

J. E. LEBENSOHN.

MEDICAL TREATMENT IN SENILE CATARACT: REPORT OF CASES. V. DERKAČ, Klin. Monatsbl. f. Augenh. **100**: 236 (Feb.) 1938.

The transparency, growth and refractive power of the lens can be maintained only by an active metabolism in the lens. Fundamental research of a number of authors revealed active catalyzers preserving the function of the lens: the three systems of oxydo-reduction (glutathione, vitamin C and vitamin $B_2$) and vitamin A. The three systems are transmitted through the ciliary vessels, and vitamin C is formed in the lens itself. Other less known factors influencing the chemistry of the lens are derived from the endocrine glands and from the mineral metabolism. Starting from these considerations, the author treated 7 patients with subconjunctival injections of vitamin C, supplemented with intramuscular injections of vitamin $B_2$ and a corroborant

diet. Two of these patients were dismissed after 10 ineffective treatments, and 2 discontinued them. In 2 men, aged 57 and 63, respectively, satisfactory results were obtained after several months of this therapy. In other patients, who were treated for shorter periods, the lens cleared at the surface and from the periphery, according to the location near which the subconjunctival injection took place. In Derkač's opinion beginning cataract may be retarded in its development and cleared to some extent but not dissolved completely. He was unable to explain why the injection of vitamin into the anterior chamber, or subconjunctivally was effective, while its intravenous or hypodermic application yielded no result, although the two latter methods were followed by a rise of the ascorbic acid in the anterior chamber.

K. L. STOLL.

## Methods of Examination

OPHTHALMOSCOPIC EXAMINATION WITH RED-FREE LIGHT. T. A. Vos, Klin. Monatsbl. f. Augenh. **100**: 195 (March) 1938.

Vos comments on the great role played by ophthalmoscopic examination with light free from red rays at the ophthalmic clinic in Zurich, where such an examination is a part of the routine. He describes the apparatus of Vogt, which he considers the best. Large carbon lights furnish the clearest picture. Red-free lamps devised by other authors are discussed as to their merits, and 21 cases in which examination was done with this type of lamp are briefly recorded. Research on the macula lutea was revived by this method along several lines, which are reviewed by Vos. He discusses the possibilities of recognizing the yellow color of the macula by other than the anatomic and spectral-analytic methods, which have demonstrated its existence. The author elaborates on the controversy between Gullstrand and his followers, who doubt the possibility of observing the yellow color ophthalmoscopically, and Dimmer and Van der Hoeve, who have noted it in certain conditions, such as ischemia of the retina or closure of the central retinal vein. The mercury silver arc lamp is insufficient to demonstrate the yellow color, whereas Vogt's red-free light allows the study of the yellow color and its anomalies. One may observe this color endoptically in one's own eye by the method designed by Vogt.

Observations were made on the macula of 4 patients with toxic amblyopia. The papillomacular bundle is always involved in this disease, and the macula becomes included in the process. Extensive abolition of the design of the nerve fibers was observed in 2 cases of atrophy of the optic nerve, and indistinct demarcation of the papillomacular bundle in 2 cases of temporal pallor of the optic nerve. Cystoid degeneration of the macula was found as a complication of iridocyclitis and choroiditis. Defective vision could be explained as a result of this condition in only 1 case by means of examination with the red-free light. Perfect vision, on the other hand, may be preserved in the presence of macular changes. In 2 cases of closure of the central retinal vein there was cystoid degeneration of the macula, and in 1 case there was absence of the macula. One of the colored illustrations depicts a condition which resembled a hole in the macula under ordinary

illumination; red-free light, however, demonstrated a cyst with a thin, ruptured wall. Vos's observations prompted him to accept the view that the yellow color of the macula actually exists.

K. L. STOLL.

## Neurology

CHRONIC TRAUMATIC SUBDURAL HEMATOMA AS A CAUSE OF CHOKED DISC. C. KING, Am. J. Ophth. 20: 149 (Feb.) 1937.

King comments on the paucity of ophthalmic literature on chronic subdural hematoma in which ocular symptoms are frequently observed. He reports the case of a 30 year old white woman who had noticed blurred vision in the right eye for two weeks. Five weeks previously she had fallen on her face. A choked disk of 2.5 diopters was found in the right eye, but physical examination gave otherwise negative results until a month later, when it was noted that the deep reflexes in the right arm and left leg were hyperactive, and that there was a bilateral Chaddock and Strümpell sign. A ventriculogram was undertaken, a trephine opening being made to the right of the occipital protuberance. When the needle was introduced a collection of coffee-colored fluid was obtained, it being obvious that there was a subdural hematoma. The clot was removed by through and through irrigation, and the patient made an uneventful recovery. King discusses subdural hematoma from the standpoint of etiology, age of incidence, symptoms, diagnosis, treatment and pathologic picture in relation to operation. A survey of 224 cases reported revealed an incidence of choked disk in approximately 44 per cent of the cases.

W. S. REESE.

AN ETIOLOGIC STUDY OF A SERIES OF OPTIC NEUROPATHIES. J. I. MOORE, Am. J. Ophth. 20: 1099 (Nov.) 1937.

Moore gives the following summary:

"A series of 150 patients presenting optic neuropathies, who had been admitted to the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital, is studied. Of these 15.3 per cent were due to intracranial tumor; 3.3 to pseudo-tumor; 19.3 to syphilis; 5.9 to arteriosclerosis; 4.0 to posterior-sinus disease; 18.0 to multiple sclerosis; 1.3 to focal infection; 6.6 to toxic amblyopia; 1.3 to Leber's disease; 0.66 to intracranial aneurysm; 10.0 to miscellaneous conditions; while in 14.6 per cent the exact etiologic factors could not be determined."

W. S. REESE.

NEUROMYELITIS OPTICA. F. B. FRALICK and R. N. DEJONG, Am. J. Ophth. 20: 1119 (Nov.) 1937.

Fralick and DeJong give the following summary:

"1. Neuromyelitis optica is a disease that is characterized by the presence of an acute bilateral optic neuritis accompanied by a diffuse or transverse myelitis.

"2. Pathologically there are areas of complete demyelinization and axis-cylinder destruction together with microglial and lymphocytic proliferation.

"3. A case showing both the clinical and histopathologic characteristics of the disease has been reported."

W. S. REESE.

OCULAR SYNDROME OF MYASTHENIA. A. PALEARI, Riv. oto-neuro-oftal. 14: 356 (July-Aug.) 1937.

Paleari discusses 6 cases of myasthenia in which the ocular symptoms were the first to appear. The fact that frequently a disturbance of the ocular muscles is the only sign of the disease for a considerable time will often lead to mistaken diagnosis. In every case of ophthalmoplegia of obscure etiology myasthenia must be kept in mind. Even though prostigmine (the dimethylcarbamic ester of m-oxyphenyl-trimethylammonium methylsulfate) has less effect on the ophthalmoplegia of myasthenia, it constitutes a satisfactory therapeutic test. Also, Paleari comments that its action points to the possibility that the lesion responsible for the symptoms may be situated in the mesencephalon. No histologic sign of such a lesion was found in any of the cases reviewed.

F. P. GUIDA.

ISOLATED PARALYSES OF THE ABDUCENS NERVE DUE TO FRACTURE OF THE BASE OF THE SKULL. F. AGNELLO, Riv. oto-neuro-oftal. 14: 492 (Sept.-Oct.) 1937.

Agnello reviews 1 case—the fourth in his collection—of secondary paralysis of the abducens nerve following trauma to the skull. He reviews the symptoms of fractures of the skull located in the region of the petrous bone, the usual site of lesions of the sixth nerve.

F. P. GUIDA.

## Ocular Muscles

VOLUNTARY NYSTAGMUS: REPORT OF A CASE. A. MIKLÓS, Klin. Monatsbl. f. Augenh. 100: 186 (March) 1938.

Miklos describes various types of nystagmus and their characteristics and etiology and cites references in the literature. The case of a physician aged 27 is reported who voluntarily produced nystagmus with pendular motions of a small amplitude. At first he was able to induce the nystagmus only with his eyes open and gazing straight ahead. After some practice he succeeded in producing it with his eyes in the lateral and upward positions, but when he turned his eyes downward the nystagmus was incomplete. Finally he was able to elicit the nystagmus with his eyes closed. The motion was rapid, up to from 500 to 600 waves a minute with an amplitude of from 1 to 2 mm. The number of waves decreased after many demonstrations, and decided fatigue of the muscles of the eye occurred.

Miklos concludes that the origin of nystagmus remains unknown notwithstanding many attempts to explain it.

K. L. STOLL.

## Operations

MODIFICATION OF THE DESMARRES OPERATION FOR TRANSPLANTATION OF THE PTERYGIUM. H. MILLER, Am. J. Ophth. **20:** 165 (Feb.) 1937.

Miller reviews the necessary steps in operations for pterygium and the well known methods employed. He describes an operation in which he utilizes the growth as a conjunctival covering. The following summary is given:

"As stated above, the method I employ is really an improved technique of the Desmarres operation; however, I had employed this operation many years before becoming aware of the Desmarres operation and its publication. The operation fully covers the points as set out in the beginning of this paper. The growth is fully removed and placed in a position least furthering its reformation, and so utilized that the wound is closed without loss of any of the conjunctival covering. This procedure favors rapid healing and reduces the possibility of recurrence to a minimum. The method employed conforms to modern principles of surgery."

W. S. REESE.

## Orbit, Eyeball and Accessory Sinuses

RECENT RESEARCHES ON THE MORPHOLOGY AND TOPOGRAPHY OF CERTAIN ELEMENTS IN THE ORBITAL REGION. G. WINCKLER, Ann. d'ocul. **175:** 368 (May) 1938.

This article is published for the purpose of adding corrections to some classic contributions on the morphology or topography of certain elements in the orbital region. It consists of a synthesis and summary of observations that the authors formed while working on a series of preparations. Minute examination of the lids and the contents of the orbital cavity allowed them to modify the classic conception regarding the site of the orbicularis muscle of the lids and the external palpebral ligament as well as the muscle sheath and the capsule of Tenon.

The author discusses each of these anatomic structures in detail and divides the palpebral part of the orbicularis muscle of the lids into five portions as follows: (*a*) the preciliary marginal portion; (*b*) the pretarsal portion; (*c*) the preceptal portion; (*d*) the retrociliary marginal portion, or muscle of Riolan, and (*e*) the lacrimal portion, or muscle of Horner. Two illustrations accompany the article.

S. H. MCKEE.

SPONTANEOUS ORBITAL HEMORRHAGE DURING MENSTRUATION: REPORT OF A CASE. H. SCHEYHING, Klin. Monatsbl. f. Augenh. **100:** 357 (March) 1938.

Birch-Hirschfeld compiled reports of 80 cases of spontaneous orbital hemorrhage. Among the causes mentioned were hemophilia, scurvy and local and general diseases of the wall of the blood vessels. Relation to menstruation is rare in this type of hemorrhage. Scheyhing's patient, a

woman aged 38, felt severe pain in her right orbit on arising, which was associated with collateral headache and followed by vomiting. Soon afterward she noticed dark blue discoloration and protrusion of the eyelids, which were finally swollen shut. The exophthalmos disappeared after three weeks, and the eye could be moved freely again. No etiologic factor could be found. This case belongs to a group of 5 cases in which vicarious hemorrhages in the orbit occurred simultaneously with menstruation, during the menopause or during weaning of an infant. The cause of the disturbance of the ovarian function in this case was unknown.

K. L. STOLL.

## Parasites

FILARIA IN THE ANTERIOR CHAMBER OF THE EYE. C. A. GABRIELIDES, Ann. d'ocul. **175:** 581 (Aug.) 1938.

Two groups, the nemathelminthes and the plathelminthes, have a direct or indirect action on the human eye and its adnexa. Among the menathelminthes, Filaria, and particularly the species Filaria loa, is without doubt the parasite that is most often found in this connection in Greece, where it is extremely rare to see a patient with an intraocular parasite, and when it is found it is generally a Cysticercus. In most of the published cases it is the conjunctival sac that has been invaded by a Filaria. Penetration of this parasite into the anterior chamber constitutes a rarity.

A case is described which is of special interest because the subject had never been out of Greece. The development was dramatic, and owing to the penetration of almost the whole of the ciliary body of the eye in the short time of one night it was necessary to resort to enucleation. Following a description of the case, the parasite is classified and the mode of contamination is mentioned. A review of the cases in the literature from 1771 to date shows this to be the first case encountered in the Mediterranean area. Three illustrations and a bibliography accompany the article.

S. H. MCKEE.

## Pharmacology

NEO-SYNEPHRINE. W. L. POST, Am. J. Ophth. **20:** 170 (Feb.) 1937.

Post discusses the chemistry of neosynephrin and the action of the epinephrine group and physostigmine salicylate. After experiments on 50 eyes, he draws the following conclusions:

"In ophthalmoscopy neo-synephrine has the properties of other epinephrines. It produces mydriasis as quickly, as fully, and as safely as any mydriatic. It is non-irritating. It is stable. It will reduce tension in the glaucomatous and in the normal eye. It may elevate the tension as will other epinephrines but in a very limited experience this has not occurred in glaucoma if some miosis was maintained with eserine."

W. S. REESE.

## Physiology

SOME CLINICAL NOTES ON THE NATURE OF THE RETINAL VENOUS PULSE. N. PINES, Brit. J. Ophth. 22: 470 (Aug.) 1938.

This lengthy paper is based largely on the observations of the author. The possible nature of the spontaneous venous pulse is discussed. Pines draws the following conclusions:

"1. The spontaneous retinal venous pulse is seen only on the disc and is the intensification of the ordiary venous pulse depending upon the angle of the bend of the vein when entering the disc.

"2. It is of no clinical significance whatsoever.

"3. The venous retinal pulse vacillates round the intra-ocular tension."

W. ZENTMAYER.

## Retina and Optic Nerve

THE X-RAY THERAPY OF RETINAL VEIN THROMBOSIS. H. S. GRADLE, Am. J. Ophth. 20: 1125 (Nov.) 1937.

Gradle discusses thrombosis of the retinal veins from an etiologic standpoint and summarizes 37 cases of his own, including 7 in which irradiation was administered. He concludes that irradiation may be helpful in preventing secondary glaucoma in these cases but that it does not accelerate absorption of retinal hemorrhages or help vision.

W. S. REESE.

THROMBOSIS OF THE CENTRAL VEIN OF THE RETINA TREATED WITH HEPARIN. N. HOLMIN and K. G. PLOMAN, Lancet 1: 664 (March 19) 1938.

Holmin and Ploman observed the gradual return of vision in an eye with thrombosis of the central vein of the retina after treatment with heparin. The patient was given intravenous injections of heparin. On the tenth day of treatment the patient had no subjective symptoms. Delimitation of the papilla was only slightly indistinct. The veins were rather dilated. Parapapillary hemorrhages were still visible, though reduced in size, and were paler and thinner; otherwise there were no hemorrhages anywhere in the fundus. Vision was 0.9 (—0.5) and a month later 1 (—0.5).

EDITOR'S ABSTRACT (J. A. M. A.)

A PARTICULAR FORM OF UNILATERAL OPTIC NEURITIS: SEGMENTARY NEURITIS. J. BOLLACK, S. DELTHIL and G. OFFRET, Ann. d'ocul. 175: 421 (June) 1938.

Optic neuritis has been the subject of numerous classifications, particularly from the standpoint of anatomy, clinical considerations, evolution and etiology. There seem to exist, however, particular cases that cannot be placed in the usual classification.

The observations reported here concern a particular type of unilateral neuritis, which differs from the classic types. The symptoms and course in the 3 cases were similar, and especially the symptoms seemed to warrant considering the cases as a definite type. The 3 cases are then

reported in detail, and while there were some minor differences, the resemblances were striking in that the visual disturbance was unilateral in each case, edema of the papilla was well marked but not prominent, and there were vascular changes with some juxtapapillary hemorrhage on a section of the disk. In each case the central vision was only slightly affected or normal. The roentgenographic examination gave completely negative results. Two of the patients, however, showed slight inequality of the pupils, though none of the patients were syphilitic.

S. H. McKee.

Changes in the Fundus Oculi in Diabetic Patients. E. Heinsius, Klin. Monatsbl. f. Augenh. **100**: 207 (Feb.) 1938.

Heinsius reports on the examination of the fundus of 221 diabetic patients in an exhaustive publication containing much noteworthy detail. Typical retinitis diabetica was found in 45 of the patients. For 102, exact data were obtained and recorded regarding the duration and severity of the disease, insulinization, content and fluctuation of the blood sugar, hypoglycemic conditions and blood pressure. Records of previous ophthalmoscopic examinations were available for 5 patients. Of these 102 patients, 22 presented diabetic retinitis; in 16 it was complicated with arteriosclerotic changes and in 1 patient with atrophy of the optic nerve. The blood sugar rate varied between 150 and 350 mg. per hundred cubic centimeters, and hypoglycemic conditions or diatheses seemed to have no bearing on the development of diabetic retinitis. The blood pressure was slightly increased in more than 50 per cent of the patients, and hypertonic signs were absent in the fundus. Arteriosclerosis may be a contributory, but not an essential, factor in bringing about diabetic changes in the retina. The condition was considered hypertonic only in those cases in which there were present Gunn's phenomenon, the typical appearance of the retinal vessels and general hypertonia. Several illustrative tables are included in the report. Some records showed that diabetic changes in the fundus may disappear completely, so that negative findings do not signify that previous changes existed. Women showed changes of the fundus twice as often as men. Diabetic hemorrhages in the retina were the exception in patients less than 50 years of age. The author expressed surprise that white spots without hemorrhages were found in the retina with one exception only in women under 50 years of age who had a blood pressure of less than 140 mm. of mercury. The patients' general physical condition may have been the cause of this. In the pathogenesis of diabetic retinitis, arteriosclerosis and hypoglycemic conditions have no part; it is most likely that the constellation of several factors is instrumental in producing this condition.

K. L. Stoll.

## Trachoma

Subconjunctival Epithelial Cyst and Trachoma. S. Werner, Finska läk.-sällsk. handl. **80**: 919 (Dec.) 1937.

Werner describes an epithelial cyst in the conjunctiva which was about 1.5 cm. long and 0.3 cm. thick. Nine years earlier trachomatous

granulations in the same eye had been treated by expression. In the connective tissue of the lids, numerous trachomatous granulations were still seen. Werner ascribes the tumor to epithelial proliferation or to the formation of folds in the connective tissue, probably due to the inflammatory trachomatous process.

J. A. M. A. (W. ZENTMAYER).

## Tumors

LYMPHOID TUMOR OF THE LACRIMAL GLAND. H. A. COOKSON and A. MACRAE, Brit. J. Ophth. **22**: 385 (July) 1938.

A girl aged 9 years received a blow over the right eye about six months before a mass appeared in the region of the lacrimal gland. There was profound anemia, but the blood picture was at no time suggestive of leukemia. The final diagnosis was megalocytic anemia. The child died three months later. Postmortem examination showed enlargement of the spleen and liver, small rubbery glands in the mesentery and a tumor of the lacrimal gland with a similar feel.

The lacrimal tumor was composed of masses of large and small lymphocytes lying in a delicate fibrous stroma. The cells infiltrated every portion of the tissue. There was no capsule. The specimen is compatible with lymphosarcoma or a leukemic infiltration of the lid. Sections of a gland from the abdomen showed a similar histologic structure.

The authors' belief is that the growth on the lacrimal gland was a leukemic infiltration.

Illustrations accompany the article.

W. ZENTMAYER.

SINGULAR ASPECT OF AN ORBITOPALPEBRAL TUMOR (EPITHELIOMA OF THE MEIBOMIAN GLANDS). P. DUPUY-DUTEMPS, Bull. Soc. d'opht. de Paris **50**: 70 (Feb.) 1938.

A woman of 65 years had noted a small lump on the left lower lid about four years previously. It was thought to be a chalazion and was treated as such. The extent of the growth is indicated in a photograph of the patient. The mass was adherent to the floor of the orbit and had so invaded the orbit that the globe had become immobile. No adenopathy of the preauricular or submaxillary glands was present. Visual acuity and the fundus were normal. The diagnosis was based on the clinical aspect of the condition.

L. L. MAYER.

## Uvea

TREATMENT OF PROLAPSE OF THE IRIS BY TRICHLOROACETIC ACID (TECHNIC OF BETTMAN AND BARKAN). A. MAGITOT and A. DUBOIS-POULSEN, Ann. d'ocul. **175**: 449 (June) 1938.

Among the complications following the extraction of cataract, prolapse of the iris is the most frequent. In spite of the usual precautions taken to prevent it, the condition at times results. Under these conditions the surgeon hesitates to start anew with a further operation, so

the procedure of Bettman and Barkan, by which the hernia is coagulated with trichloroacetic acid, deserves to be better known, especially as it gives excellent results.

The authors give the details of this method and cite 11 cases in which it was done, the results entirely confirming the conclusions of Bettman and Barkan. The method is especially useful for a small prolapse of the iris. While it is not to be advised for a large prolapse, it is quite satisfactory for hernias of small or medium size.

S. H. McKee.

Boeck's Iritis. G. Osterberg, Nord. med. tidskr. **16:** 1125 (July) 1938.

Osterberg reports a case in which a torpid, indolent, monocular nodulous iritis developed in a girl aged 14 years, and in the course of a year reduced the vision to 2.50 and threatened perforation of the eye. Enucleation was contemplated. There were no pulmonary symptoms, but the roentgenographic picture of the lungs resembled that of miliary tuberculosis, and operation was deferred. In the course of nine months the patient recovered spontaneously from the ocular condition, with restoration of vision and of the exterior of the eye almost to normal and spontaneous regression of the pulmonary changes. Microscopic examination of tissue from an apparently healthy tonsil demonstrated sarcoid of Boeck. The author asserts that there is a distinct Boeck's iritis which is not identical with iritis tuberculosa; it is less painful, less destructive and more proliferative than iritis tuberculosa. The differential diagnosis must be based on the patient's general condition, the tuberculin test and the roentgenographic and microscopic examinations. Iritis is a relatively rare symptom in Boeck's disease, occurring in from about 5 to 10 per cent of cases. Twenty-seven cases of Boeck's disease with iritis are tabulated from the literature.

W. Zentmayer.

Heerfordt's Syndrome (Uveoparotid Fever). M. Jersild, Ugesk. f. læger **100:** 756 (July) 1937.

In Jersild's 2 cases of Heerfordt's syndrome roentgenographic changes in the lungs led to the diagnosis of sarcoid of Boeck. In spite of the excessive processes, the patient felt remarkably well, and the Mantoux reaction, as frequently described in cases of sarcoid of Boeck and Heerfordt's syndrome, was positive only when larger doses of tuberculin were given. In 1 of the cases in which there was an exanthem, biopsy supported the diagnosis. The author suggests that since the etiology of sarcoid of Boeck is not clear, the relation of the disease to uveoparotid fever, which generally appears as an infectious disease with acute onset, may open new perspectives. Heerfordt's syndrome, he says, is surely the initial stage in a long-continued chronic infectious disease.

W. Zentmayer.

## Vitreous

RELAPSING HEMORRHAGES IN THE VITREOUS AND MENSTRUATION. P. SATANOWSKY, Arch. de oftal. de Buenos Aires 13: 173 (March) 1938.

Three cases of recurring hemorrhages in the vitreous are reported, apparently connected with menstrual disturbances. In 1 case improvement was noticed after medication with calcium. The literature on recurring hemorrhages in the vitreous is reviewed.

C. E. FINLAY.

## Therapeutics

CHEMOTHERAPY OF OCULAR COMPLICATIONS OF GONORRHEA BY SULFANILAMIDE DERIVATIVES. M.-A. DOLLFUS, DI MATTEO and PROUX, Bull. Soc. d'opht. de Paris 50: 73 (Feb.) 1938.

Various ocular conditions in which the gonococcus was definitely proved to be the inciting cause or was thought to be present although not proved were treated with sulfanilamide. Cases of bilateral dacryoadenitis, gonorrheal conjunctivitis of the adult and conjunctivitis of the newborn are described in some detail. The authors feel that the results are comparable to the results obtained and reported in cases of gonorrheal urethritis. Smears after treatment with sulfanilamide were negative for the organism in a much shorter time than when the drug was not used. For adults the dose used was 3 Gm. four times a day, while newborn infants were given 0.5 Gm. in each of four feedings by bottle. Cyanosis occurred in several infants, and the dose was reduced to 0.25 Gm. four times a day. The patient should be kept under strict observation during the period of treatment.

L. L. MAYER.

# Society Transactions

EDITED BY W. L. BENEDICT

## COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

ALEXANDER G. FEWELL, M.D., *Chairman*

*Oct. 20, 1938*

WARREN S. REESE, M.D., *Clerk*

JAW WINKING: MARCUS GUNN PHENOMENON. DR. CARROL R. MULLEN.

A case of jaw winking associated with congenital ptosis is reported.

DISCUSSION

DR. SAMUEL B. HADDEN: Cases such as Dr. Mullen reported are rather uncommon, the first case being described in 1883, and approximately 100 cases have been reported to date. The phenomenon is one that has not been adequately explained, as yet. As Dr. Mullen's case so clearly showed, when the patient opens his mouth there is a tendency for the upper lid to become elevated, with resulting widening of the palpebral fissure. In this particular case this movement occurred when the patient chewed or talked rapidly and enthusiastically. When the mouth is at rest, the palpebral fissure on the involved side is slightly narrower than on the good side, and in many of the reported cases the pupil on the involved side is smaller.

The cases as reported to date may be divided into four groups: (1) those in which the upward movement of the eyelid occurs when the mouth is opened or directed to the opposite side; (2) those in which the upward movement occurs only when the mouth is opened but not on lateral deviation of the jaw; (3) those in which elevation of the lid occurs only on lateral movement of the jaw but not on simply opening the mouth, and (4) those in which the upward movement of the eyelid occurs in association with movement of the jaw but in which there is no ptosis.

Various explanations have been offered, but when it is recalled that when the mouth is opened wide there is normally an upward movement of the eyelid, it appears that the phenomenon is most likely the result of an exaggerated normal associated movement. This explanation is the one most generally accepted, but against it is the fact that many times the movement occurs when the jaw is passively opened or moved.

The treatment of the disability is most difficult, although Grant recently reported a case in which relief was obtained through a section of the motor supply to the involved pterygoid muscle.

DR. FRANCIS HEED ADLER: I noticed in the moving picture that there was a definite lack of winking in the left eye of this patient. Was this a constant finding? The theory which best explains the Marcus Gunn phenomenon is, in my opinion, that of a cortical lesion. The only muscles associated with the eye which have a separate cortical innervation are the levator and orbicularis muscles of the lids. The cortical center for the levator muscle lies close to the cortical center for the movements of the jaws. This seems much more likely to explain the association of jaw winking by a congenital lesion in this region than to assume a connection between the fibers of the fifth and the third nerve farther down in the pathway.

DETACHMENT OF THE RETINA SUCCESSFULLY TREATED WITH THE THERMOPHORE: REPORT OF TWO CASES. DR. H. MAXWELL LANGDON.

CASE 1.—F. D. W., a white woman aged 55, was seen first on July 7, 1924, for the correction of about 2 D. of myopia in the right eye and 1 D. of myopic astigmatism in the left eye. He was seen again in 1927 for refraction. In July 1930 some floating opacities of the vitreous developed. At that time the systolic blood pressure was 180. Two teeth showed infection at the root and were extracted. The vitreous cleared in the right eye, but some dots remained in the left eye.

In 1934 the patient was again seen for refraction. On March 29, 1938, he was seen with some blurring of vision, which became 5/4 on correction of the refractive error. On May 4 he had a shadow over the left temporal field; central vision was still 5/5 (partly), but the whole temporal field of the right eye was lost because of complete detachment of the nasal portion of the retina, with a large tear up and in. The greatest elevation was seen with a + 10 D. sph.

On May 6 the patient was given nine applications with the thermophore at 160 F., each application being of one minute's duration. Reattachment occurred, and the patient was discharged on May 27 with corrected central vision of 5/5 + and a normal visual field. The vitreous still shows a few floating dots.

CASE 2.—W. T. L., a white man aged 55, was operated on in the Episcopal Hospital for Dr. Andrew Knox in February 1936 for detachment of the upper portion of the retina of the right eye. The patient was shown at this section after the operation with complete recovery of both central and peripheral vision.

On June 20, 1938, he came to the dispensary of the Presbyterian Hospital complaining of blurring of vision of the left eye for two months, the diagnosis of a physician who had examined him being detachment of the lower portion of the left retina.

The lower half of the retina was elevated about 8 D., the upper portion of the field being lost; central vision was 6/60. No tears were seen in the detached portion. On June 27 his left eye was operated on, eight applications with the thermophore being made. Recovery of peripheral vision was complete, the field becoming normal, but the central vision was improved to but 6/9, undoubtedly as the result of delay in operation.

So far, I have operated on 10 eyes by this method. Perfectly satisfactory results have been obtained for 7, vision ranging from 5/5 + to 5/22. The vision of 5/22 was obtained in a case in which detachment was of four months' duration. In 1 other case a perfect result was obtained for two months, when the patient, in spite of definite advice, exerted himself violently and suffered a redetachment. His vision, however, has improved from 2/60 to 5/4, and his field from only a small upper portion to a normal outline. One of the other patients was a man with 10 D. of myopia, who had a fall sufficient to fracture his lower maxilla. He was not operated on until two months after the accident. The upper half of the retina was detached. The operation replaced this, but three weeks later, before he was discharged from the hospital, there was a fresh detachment to the temporal side, although the retina at the site of the first operation stayed in place.

DISCUSSION

Dr. James S. Shipman: I should like to ask Dr Langdon if I understood him clearly in saying that he released the retinal fluid before he made his applications with the thermophore? If this is true, it is contrary to any of the methods which I have used or have read about.

Certainly it would seem to me that a wet field would interfere with the application of any type of heat or desiccation, and also with the globe soft or partially collapsed it would be more difficult to apply such an electrode. I am well aware of the fact that this subretinal fluid must be released in order for the retina to come up against the coagulated points or areas of the choroid, but this can be done easily after the application of heat or of diathermy needles has been made.

I think that Dr. Langdon should not feel badly about a central visual result of 5/9. To me this would appear to be an excellent result.

One point in favor of Dr. Langdon's method of using the thermophore for surface coagulation is that it can be used on any electric current, and with the excellent results which he has obtained it sounds most interesting.

Dr. Leighton Appleman: To what does Dr. Langdon attribute his good results?

Dr. H. Maxwell Langdon: In answer to Dr. Shipman's question, it makes little difference with this method whether the fluid is permitted to escape before or after the application of the thermophore. It is not necessary to have an eye sufficiently rigid to permit penetration of the sclera if this method is used.

In answer to Dr. Appleman's question, I think that the good results have been obtained because there is a sufficient choroidal exudate to weld the retina to the choroid and because great care has been used in the after-treatment.

OBJECTIVE SIGNS OF BLINDNESS WITH PARTICULAR REFERENCE TO APPLICANTS FOR PENSION FOR BLINDNESS. DR. ALFRED COWAN.

Blindness, according to the various acts for granting pensions to the blind, may be defined as partial or complete. The National Society for the Prevention of Blindness considers a person with vision of 6/60 with the better eye to be practically blind for all ordinary occupations. This is in agreement with the definition of economic blindness prepared by the American Medical Association. Pennsylvania has adopted central visual acuity of 10/200 or less in the better eye with correcting glasses as a definition of economic blindness.

Generally speaking, a central visual acuity of 6/60 or 20/200 is a liberal interpretation of blindness. This represents a visual efficiency of 20 per cent according to the table of Sterling and Snell. This is far from actual blindness, and the examiner might have to remind himself in his observation of the actions of applicants for pensions that a person even with 3/60 vision can recognize, although hazily, all large objects at ordinary distances. In daylight he can see the different colors of the landscape, the outlines of buildings and moving automobiles at a considerable distance and moving people at some distance and can even recognize their features at 5 or 10 feet (152 or 304 cm.). He can read large headlines in the newspapers. Some persons who are accustomed to their partial blindness get around and do things which are remarkable.

The prize of a regular monthly dole or pension is sufficient to induce many a person to simulate blindness or to exaggerate an existing partial disability, and experience justifies my stating that every applicant for state aid for blindness is a potential malingerer. Expert skill, knowledge, judgment and alertness are often necessary for diagnosis when the sight seems low, out of all proportion to the objective signs. A person may have sufficiently low vision to be eligible for a pension and still have none of the signs of the totally blind person.

Special test cards with the larger letters cut out, doubling the regulation testing distance, poor illumination and any other of the known stratagems for the direction of malingering should be a part of the equipment of every examiner.

A knowledge of the objective signs of absolute blindness is not often useful for the purpose of diagnosing partial blindness as defined by regulation in the various states. The amount of disability which might be caused by a certain lesion must, therefore, depend on the judgment, experience and knowledge of the examiner, and if an applicant is intelligent, experienced or coached, it will be extremely hard to prove that he is a fraud.

BILATERAL ENDOPHTHALMITIS COMPLICATING PNEUMOCOCCIC SEPTICEMIA: REPORT OF A CASE. DR. JACOB REBER and DR. HAROLD G. SCHEIE.

This article will be published in full in a later issue of the ARCHIVES.

RABBIT ANTIPNEUMOCOCCUS SERUM IN THE TREATMENT OF ULCUS SERPENS. DR. HAROLD G. SCHEIE.

Rabbit antipneumococcus serum, because of its smaller antibody molecule, higher antibody titer and availability in increasing numbers of types, as compared with horse serum, might be used to great advantage in the treatment of ulcus serpens. An 87 year old Negro was treated in this manner with a favorable outcome.

DISCUSSION

DR. LEON H. COLLINS JR.: During the past two years there has been an increasing interest in rabbit pneumococcus antiserum both for typing and for therapeutic purposes. It is now possible to diagnose the type of pneumococcic infection of the eye much earlier than in the past. A serum is now available which is more concentrated and usually gives less reaction than former serums. The evidence at present available suggests that the antibody molecule of rabbit pneumococcus antiserum is of smaller size than that of the horse pneumococcus antiserum. Horsfall and his associates have been able to demonstrate type specific rabbit antibodies in the pleural fluid of some patients with pneumococcic empyemas who had received rabbit pneumococcus antiserum intravenously.

The patient presented by Dr. Scheie had received rabbit antiserum both locally and intravenously. It would appear that the treatment here had influenced the course of the disease favorably, but further investigation is necessary to determine the mode of action and the relative value of these two methods of administration in pneumococcic infections of the eye.

DISCUSSION

DR. FRANCIS HEED ADLER: I rather doubt that the antibodies, even in rabbit serum, would get into the normal aqueous when injected into the blood stream. It is possible, however, that the small size of the molecule in rabbit serum aids in the penetration into the cornea when the serum is instilled in the conjunctival cul-de-sac. Although the cost of this serum may at first thought seem prohibitive, it is a small price to pay for saving an eye, and most manufacturing companies or insurance carriers would be glad to buy it rather than have to pay the compensation for the total loss of an eye.

DR. LOUIS LEHFRELD: Twenty-one years ago I read a paper before this section entitled "Serum Therapy as Applied to Pneumococcic Infections of the Eye." I note from the reprint of that paper, which I now have before me, that I was secretary of the Pneumonia Commission of Philadelphia in 1917. It was the purpose of this commission to disseminate information on the prevention of pneumonia and on its treatment by the use of antipneumococcus serum.

At that time there were recognized four types of the pneumococcus. Serums were available for type I and type II. It occurred to me that a mixture of serums of type I and type II might be of service in the treatment of dendritic keratitis due to the pneumococcus. With the advice of Dr. C. Y. White, director of the laboratories of the health

department, Philadelphia, there were prepared for me ampules containing serums of type I and type II. This mixture of serums was used locally in the eyes of patients having pneumococcic ulcerative keratitis. My report indicates that encouraging results were obtained from its use.

I am gratified to know that great advances have been made in the numerical classification of the various types of pneumococci since the date of my report and that serums are now available, depending on the type of organism present.

I feel that Dr. Scheie is working in the right direction in the local administration of antipneumococcus serum obtained from the rabbit.

# Correspondence

## HOMONYMOUS HEMIANOPIC PARACENTRAL SCOTOMA

*To the Editor:*—In a paper on homonymous hemianopic paracentral scotoma in the November issue of the ARCHIVES (20: 846, 1938) it is stated that in textbooks on perimetry little discussion has been devoted to this type of defect and that in my "Introduction to Clinical Perimetry" I have "merely defined the defect." The authors quote from chapter 5 of the first edition, but make no reference to the short discussion on the subject in chapter 11, which is illustrated by reports of 2 cases, 1 of homonymous congruous hemianopic central scotoma with invasion of the fixation area and 1 of homonymous congruous paracentral scotoma, both from my own collection. That this subject is not neglected in the literature is shown by a reference to volume 7 of Wilbrand and Saenger's "Neurologie des Auges" (1917), in which over 20 pages dealing with more than 30 cases are devoted to it.

The authors also state that "Traquair's term 'fixation area' is not clear." This term is defined in chapter 1 as the projection of the macula in the field of vision, thus being distinguished from "macular area," which refers to an organic structure. A blind man may have a macular area, but he cannot have a fixation area.

The question of sparing of the fixation area arises only in connection with central hemianopic scotoma, not with paracentral scotoma. The statement quoted from my book refers to hemianopic scotoma, not to the homonymous form alone, and is, as far as I know, not contradicted by reported cases. Central acuteness of vision may be good in either case, and the symptoms may be merely difficulty in reading.

A larger measure of unanimity in regard to terminology would be welcome. There seems little justification, for example, for calling paracentral homonymous congruous scotomas hemianopic when no part of the boundary of the defect extends to the vertical meridian of the field, or homonymous congruous sector defects scotomas when they extend to the periphery of the field.

H. M. TRAQUAIR, M.D., Edinburgh, Scotland.

# News and Notes

## SOCIETY NEWS

**Annual Congress of Ophthalmological Society of United Kingdom.**—The annual congress of the Ophthalmological Society of the United Kingdom will be held at the headquarters of the Royal Society of Medicine, Wimpole Street, London, W., on April 20-22, 1939. The subject for discussion is "The Problems of Refraction." The discussion will be opened by Mr. R. Affleck Greeves, Mr. Charles Goulden and Mr. A. Harold Levy. Members who wish to take part in this discussion should notify Mr. Frank W. Law (36, Devonshire Place, W. 1) before February 28. The Bowman Lecture will be delivered by Professor Weve, his subject being, "Diathermy in Ophthalmic Practice." The International Organization Against Trachoma and the International Association for the Prevention of Blindness will hold their annual meetings on Wednesday, April 19, at the same venue as that of the Ophthalmological Society. These meetings will be accessible to members of the congress. The annual dinner of the society will be held on April 20.

**National Society for the Prevention of Blindness.**—On Jan. 1, 1938, Lewis H. Carris, formerly managing director of the National Society for the Prevention of Blindness, became general director; Mrs. Winifred Hathaway became associate director, and Mrs. Eleanor Brown Merrill, an associate director for the past five years and formerly secretary of the society, became executive director and will relieve Mr. Carris of administrative details. John M. Glenn, one of the founders of the society, was elected an honorary vice president.

**Southwestern Society of Eye, Ear, Nose and Throat Specialists.**—This society was organized on Oct. 27, 1938, at El Paso, Texas, with the election of the following officers: president, Dr. Dake Biddle, Tucson, Ariz.; vice president, Dr. W. C. Barton, Santa Fe, N. M., and secretary, Dr. Maurice Spearman, El Paso, Tex. The organization will meet annually during the convention of the Southwestern Medical Association, according to the El Paso *Herald-Post*.

# Obituaries

## WALTER HAMILTON SNYDER, M.D.
### 1870–1938

Dr. Walter Hamilton Snyder was born in Elmhurst, Pa., on Sept. 3, 1870, of Dutch parentage.

His early life was spent in Scranton, Pa. He received his medical degree in 1891 at the University of Michigan and went to Toledo, Ohio, shortly after to specialize in work on the eye, ear, nose and throat. His specialized training was received at various clinics and universities in New York and Philadelphia and at several European clinics, notably that of Adelbert Fuchs, of Vienna.

Beginning early in his medical career in Toledo, Dr. Snyder took an active part in the activities of the local and state medical societies, serving as councilor and on various committees of both organizations. In 1907 he was president of the Toledo Academy of Medicine, and in 1908 and 1909, president of the Ohio State Medical Association. In 1913 he was appointed by Governor Cox to the board of the Ohio Commission for the Blind; he continued in this capacity until the early 1920's, when he was made president of the organization, a position which he held for many years. Dr. Snyder was a militant leader for reforms and benefits for the blind.

He wrote many articles pertaining to the eye, and he was frequently called on to address the various county and city medical societies as well as organizations outside the state, such as the Chicago Ophthalmological Society and the Detroit Ophthalmological Club. He was always alert to take advantage of new methods for diagnosis and procedure. He was the first physician in this country to perform the Elliot trephine operation for glaucoma and one of the first ophthalmologists in this country to employ the corneal microscope. He was one of the first physicians in Toledo to interest the local members of the medical profession in the use of the roentgen rays.

During the World War he served on a medical advisory committee of local physicians for men entering the service. He was a member of the Toledo Academy of Medicine and of the Ohio State Medical Society, a Fellow of the American Medical Association and also a Fellow of the American College of Surgeons and of the American Academy of Ophthalmology and Otolaryngology.

Dr. Snyder had a great interest in sports, being an ardent hunter and fisherman. He was especially interested in salmon fishing.

He died on Dec. 29, 1938, of chronic cardiac hypertrophy, at his home in Toledo. His wife, Virginia Kellogg Snyder, died in May 1937. He had no children.

## BENJAMIN FRANKLIN BAER JR., M.D.
### 1879–1938

Dr. Benjamin Franklin Baer Jr. was born in Philadelphia in 1879, the son of Dr. Benjamin F. Baer and Lucy Heath Baer, and died there on Dec. 19, 1938. His father was an eminent gynecologist.

After graduating from the Philadelphia Central High School, he entered the University of Pennsylvania, where he received the degree of B.S. in 1900 and of M.D. in 1903. He obtained his education in ophthalmology under Dr. George de Schweinitz at the University of Pennsylvania.

In 1937 Dr. Baer was appointed associate professor of ophthalmology in the under graduate school of the medical department of the University of Pennsylvania. He was at one time ophthalmologist for St. Anges Hospital and for Mount Sinai Hospital. At the time of his death he was attending surgeon at the Wills Hospital and consultant in ophthalmology at the Chestnut Hill Hospital.

Dr. Baer served as ophthalmic surgeon at Base Hospital no. 20, University of Pennsylvania Unit of the American Expeditionary Forces. His rank on his enlistment was that of lieutenant, and he was later promoted to the rank of major.

He was a fellow of the College of Physicians of Philadelphia.

He married Beatrice Stephens, who, with five children, survives him. Dr. Baer was for many years personal assistant to Dr. de Schweinitz. He was a capable ophthalmologist, and a skilful surgeon and had a large operative practice. In collaboration with Dr. de Schweinitz, he contributed several papers to the literature on ophthalmology.

W. ZENTMAYER.

# Book Reviews

**The Etiology of Trachoma.** By Louis A. Julianelle, Ph.D. Price, $3.25. Cloth. New York: The Commonwealth Fund, 1938.

This volume on the etiology of trachoma offers the first complete survey of the subject since the monograph of Axenfeld, which appeared in 1914. In view of the worldwide importance of the disease, this review should be welcomed not only by special investigators in the field but by ophthalmologists, public health workers and microbiologists in general. The extensive experience of the author has enabled him to analyze in a critical spirit the extensive literature which has now accumulated on the disease.

The volume opens with a short but adequate description of the clinical manifestations, differential diagnosis and pathologic picture of the disease. In the second chapter there follows a discussion of epidemiology and possible predisposing factors. Six black and white and one color photographs serve to illustrate this part of the text. The remaining eight chapters consider the various phases of the problem of etiology under the following headings: general considerations on etiology, general considerations on infectivity, the micro-organism associated with trachoma, the inclusion body of trachoma, the purification of the infectious agent, cultivability of the infectious agent in tissue culture and general discussion. Each chapter has its own bibliography, and a total of 783 references are cited.

In concluding, the author states that "the infectious agent of trachoma is characterized by low infectivity, occasional filterability, marked tissue specialization, ineffectual immunogenic properties, slight propagative capacity, and sensitivity to deleterious agents. The infection it causes is accompanied by inclusion bodies. . . . All these properties suggest the probability that the infectious agent is a virus. Whether the virus may be interpreted in turn as the inclusion body, or more accurately the elementary form of the inclusion body, remains to be proved, although the evidence available at the present time suggests this may be so."

It is perhaps to be regretted that publication of the book was not delayed a year or two, when it might have been possible to conclude more definitely with regard to etiology. Research on trachoma and on virus diseases in general has been progressing rapidly in recent years, and one may look soon for complete agreement among workers as to the etiology of the disease and quite likely also as to its cure.

PHILLIPS THYGESON.

**Anuario Médicao-Social de Cuba 1938.** By Dr. Tomás R. Yanes, Price, $3. Pp. 559. Habana, Cuba: Uncar, García y cía, 1938.

This alphabetical list of the medical practitioners in Cuba now appears in the edition for the year 1938. The physicians are furthermore grouped according to specialty and there are 44 ophthalmologists listed.

The doctors are also divided into those living in Habana and those living in the provinces. The names of those who died in 1937 and the names of those who graduated from the medical school in that year are given. Finally, and far from least, 24 of the doctors appear in delightful caricature with real Gallic wit, and among these is the author, Dr. Yanes.

ARNOLD KNAPP.

**Arbejder Fra Universitetets Øjenafdeling.** Volume 5. Director Prof. Henning Rønne. Copenhagen, Denmark: Levin & Munksgaard, 1938.

This is the fifth volume of publications from the ophthalmic department of Copenhagen University. It also serves as a *Festschrift* for Prof. Henning Rønne, in honor of his sixtieth birthday.

These excellent articles, many of which have appeared in the *Acta ophthalmologica,* are written in Danish, English and German and again exemplify the thorough and splendid work which is being done in ophthalmology in Denmark. The subjects of the longer articles are: "Ocular Tension in Eyes Operated on for Cataract," by Harald Anthonisen; "Interstitial Keratitis," by Esther Dalsgaard-Nielsen; "Inflammatory Orbital Affections," by Holger Ehlers; "Experimental Interstitial Keratitis in the Rabbit," by Morens Fledelius, and "Clinical Studies of Tributary Thrombosis of the Central Retinal Vein," by Viggo A. Jensen.

Professor Rønne is to be congratulated not only on his sixtieth birthday but on the excellence and the painstaking thoroughness of these valuable contributions to ophthalmology which have been written under his direction.

ARNOLD KNAPP.

**Primer Congreso Argentino de Oftalmologia.** Volume 11, pp. 648. Buenos Aires: Frascoli y Bindi, 1938.

The second session of the Congress of the Argentine Society of Ophthalmology was held on Oct. 28-30, 1936. There were nine sessions, including one devoted to operations. The report contains many important papers, some of the titles of which are: "Avitaminosis in Ophthalmology," "Angioid Streaks in the Retina," "Treatment of Convergent Strabismus," "Protein Therapy," "Treatment of Tumors of the Hypophysis," "Harada's Disease," "Trachoma," "Detachment of the Retina" and "Basal Vascular Sclerosis." At the operative clinic dacryocystorhinostomy and the intracapsular cataract extraction were demonstrated.

Congratulations are to be extended on a very successful congress, to judge by the papers presented. The subjects discussed comprise the clinical problems of the day and undoubtedly proved most interesting and useful.

ARNOLD KNAPP.

# Directory of Ophthalmologic Societies *

## INTERNATIONAL

### International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

### International Ophthalmologic Congress

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

### International Organization Against Trachoma

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

## FOREIGN

### All-India Ophthalmological Society

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.
Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

### British Medical Association, Section on Ophthalmology

President: Dr. Stewart Duke-Elder, 59 Harley St., London, W. 1.
Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.

### Chinese Ophthalmology Society

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 221 Foochow Rd., Shanghai.

### Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

### German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.

### Hungarian Ophthalmological Society

President: Prof. H. G. Ditroi, Szeged.
Assistant Secretary: Dr. Stephen de Grosz, University Eye Hospital, Maria ucca 39, Budapest.
All correspondence should be addressed to the Assistant Secretary.

### Midland Ophthalmological Society

President: Dr. W. Niccol, 4 College Green, Gloucester, England.
Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.
Place: Birmingham and Midland Eye Hospital.

### Ophthalmological Society of Egypt

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.
All correspondence should be addressed to the Secretary, Dr. Mohammed Khalil.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

### Ophthalmological Society of the United Kingdom

President: Mr. T. Harrison Butler, 81 Edmund St., Birmingham, England.
Secretary: Mr. L. H. Savin, 7 Queen St., London, W. 1.
Time: April 20-22, 1939.

### Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

### Oxford Ophthalmological Congress

Master: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield, England.
Time: July 6-8, 1939.

### Palestine Ophthalmological Society

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

### Polish Ophthalmological Society

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

### Royal Society of Medicine, Section of Ophthalmology

President: Dr. Malcolm Hepburn, 111 Harley St., London, W. 1, England.
Secretary: Dr. C. Dee Shapland, 15 Devonshire Pl., London, W. 1, England.

### Société Française d'Ophtalmologie

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7e.

### Society of Swedish Ophthalmologists

President: Prof. K. G. Ploman, Stockholm.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö.

### Tel Aviv Ophthalmological Society

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.
Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

### Tsinan Ophthalmological Society

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung, China.
Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

## NATIONAL

### American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. S. Judd Beach, 704 Congress St., Portland, Maine.
Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.
Place: St. Louis. Time: May 15-19, 1939.

### American Academy of Ophthalmology and Otolaryngology, Section on Ophthalmology

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Chicago. Time: Oct. 8-13, 1939.

### American Ophthalmological Society

President: Dr. Frederick Tooke, 1482 Mountain St., Montreal, Canada.
Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.
Place: Hot Springs, Va.

### Canadian Medical Association, Section on Ophthalmology

President: Dr. S. Hanford McKee, 1528 Crescent St., Montreal.
Secretary-Treasurer: Dr. J. A. MacMillan, 1410 Stanley St., Montreal.
Place: Montreal. Time: June 19-23, 1939.

### National Society for the Prevention of Blindness

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

## SECTIONAL

### Central Wisconsin Society of Ophthalmology and Otolaryngology

President: Dr. R. O. Ebert, 104 Main St., Oshkosh.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Oshkosh. Time: May 1939.

### New England Ophthalmological Society

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. Trygve Gundersen, 243 Charles St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

### Pacific Coast Oto-Ophthalmological Society

President: Dr. F. C. Cordes, 384 Post St., San Francisco.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: San Francisco. Time: June 19-22, 1939.

### Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. L. Goss, Cobb Bldg., Seattle.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except June, July and August.

### Rock River Valley Eye, Ear, Nose and Throat Society

President: Dr. L. J. Friend, 425 E. Grand Ave., Beloit, Wis.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501–7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

### Saginaw Valley Academy of Ophthalmology and Otolaryngology

President: Dr. Don M. Howell, Alma, Mich.
Secretary-Treasurer: Dr. Louis D. Gomon, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

### Sioux Valley Eye and Ear Academy

President: Dr. R. A. Kelly, 304 N. Main St., Mitchell, S. D.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

### Southern Medical Association, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

### Southwestern Michigan Triological Society

President: Dr. Carl Wencke, Battle Creek.
Secretary-Treasurer: Dr. A. K. Zinn, Battle Creek.
Time: Third Thursday of alternate months.

### Western Pennsylvania Eye, Ear, Nose and Throat Society

President: Dr. C. M. Harris, Johnstown.
Secretary-Treasurer: Dr. C. Wearne Beals, 41 N. Brady St., DuBois.

## STATE

### Colorado Ophthalmological Society

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.
Place: Capitol Life Bldg., Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

### Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. William M. Good, 63 Center St., Waterbury.
Secretary-Treasurer: Dr. S. J. Silverberg, 201 Park St., New Haven.

### Eye, Ear, Nose and Throat Club of Georgia

President: Dr. Grady E. Clay, 384 Peachtree St., N. E., Atlanta.
Secretary-Treasurer: Dr. J. Mason Baird, 511 Medical Arts Bldg., Atlanta.

### Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. C. W. Rutherford, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.
Place: Indianapolis. Time: First Wednesday in April.

### Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.
Place: Davenport.

### Louisiana-Mississippi Ophthalmological and Otolaryngological Society

President: Dr. Francis E. Le Jeune, 632 Maison Blanche Bldg., New Orleans.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.
Place: Gulfport, Miss. Time: May 8, 1939.

### Michigan State Medical Society, Section of Ophthalmology and Otolaryngology

Chairman: Dr. B. Fralick, 201 S. Main St., Ann Arbor.
Secretary: Dr. O. McGillicuddy, 124 W. Allegan St., Lansing.

### Minnesota Academy of Ophthalmology and Otolaryngology

President: Dr. Frank N. Knapp, 318 W. Superior St., Duluth.
Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

### Montana Academy of Oto-Ophthalmology

President: Dr. Roy Grigg, Bozeman.
Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

### New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr. Norman W. Burritt, 30 Beechwood Rd., Summit.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark.
Place: Atlantic City. Time: June 1939.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Algernon B. Reese, 73 E. 71st St., New York.
Secretary: Dr. Chester C. Cott, 333 Linwood Ave., Buffalo.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. M. Lilly, 302 Old St., Fayetteville,
Secretary-Treasurer: Dr. Frank C. Smith, 106 W. 7th St., Charlotte.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. N. A. Youngs, 322 De Mers Ave., Grand Forks.
Secretary-Treasurer: Dr. F. L. Wicks, 516–6th St., Valley City.
Place: Fargo. Time: May 1939.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. L. O. Clement, 406 State St., Salem.
Secretary-Treasurer: Dr. Paul Bailey, 833 S. W. 11th Ave., Portland.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. S. B. Fishburne, 1430 Marion St., Columbia.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Kate Savage Zerfoss, 165–8th Ave., N., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 805 Medical Arts Bldg., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. A. N. Champion, 705 E. Houston St., San Antonio.
Secretary: Dr. Dan Brannin, 1719 Pacific Ave., Dallas.
Place: Houston. Time: December 1939.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.
Secretary-Treasurer: Dr. M. H. Williams, 30½ Franklin Rd., S. W., Roanoke.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

## LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Andrew Rados, 31 Lincoln Park, Newark.
Secretary: Dr. William F. McKim, 317 Roseville Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

### Akron Academy of Ophthalmology and Otolaryngology

President: Dr. L. E. Brown, Second National Bldg., Akron, Ohio.
Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron, Ohio.
Time: First Monday in January, March, May and November.

### Atlanta Eye, Ear, Nose and Throat Society

President: Dr. J. Mason Baird, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

### Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
Secretary: Dr. Fred M. Reese, 6 E. Eager St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

### Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. N. E. Miles, 408 Medical Arts Bldg., Birmingham, Ala.
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

### Brooklyn Ophthalmological Society

President: Dr. E. Clifford Place, 59 Livingston St., Brooklyn.
Secretary-Treasurer: Dr. Frank Mallon, 1135 Park Pl., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

### Buffalo Ophthalmologic Club

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.
Secretary-Treasurer: Dr. Meyer H. Riwchun, 367 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

### Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

### Chicago Ophthalmological Society

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park, Ill.
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

### Cincinnati Ophthalmic Club

Chairman: Each member, in rotation.
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

### Cleveland Ophthalmological Club

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.
Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.
Time: Second Tuesday in October, December, February and April.

### College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Clerk: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

### Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. Hugh G. Beatty, 150 E. Broad St., Columbus, Ohio.
Secretary-Treasurer: Dr. W. A. Stoutenborough, 21 E. State St., Columbus, Ohio.
Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

### Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
Time: Second Thursday of each month from October to May.

### Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. Maxwell Thomas, Medical Arts Bldg., Dallas, Texas.
Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

### Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

### Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Arthur S. Hale, 1609 Eaton Tower, Detroit.
Time: 6:30 p. m., first Wednesday of each month.

### Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. L. A. Hulsebosch, 191 Glen St., Glen Falls.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

### Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. R. A. Gough, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. Charles R. Lees, 806 Medical Arts Bldg., Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

### Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

### Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. Louis Daily, 1215 Walker Ave., Houston, Texas.
Secretary: Dr. Herbert H. Harris, 1004 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. J. K. Leasure, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to June.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. E. N. Robertson, Concordia, Kan.
Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Paul Nilsson, 211 Cherry Ave., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Clifford B. Walker, 427 W. 5th St., Los Angeles.
Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gaylord C. Hall, Brown Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. Charles K. Beck, Starks Bldg., Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.
Secretary: Dr. Elmer Shepherd, 1606–20th St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. John E. Mulsow, 231 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.
Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.
Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. P. H. Kilbourne, Fidelity Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

### Montreal Ophthalmological Society

President: Dr. L. de G. Joubert, 690 Dunlop St., Montreal, Canada.
Secretary: Dr. K. B. Johnston, 1509 Sherbrooke St., W., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

### Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Guy Maness, 119–7th Ave., Nashville, Tenn.
Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

### New Orleans Ophthalmological and Otolaryngological Society

President: Dr. E. G. Walls, 619 Maison Blanche Bldg., New Orleans.
Secretary-Treasurer: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to June.

### New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. James W. White, 15 Park Ave., New York.
Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

### New York Society for Clinical Ophthalmology

President: Dr. Percy Fridenberg, 38 W. 59th St., New York.
Secretary: Dr. David Alperin, 889 Park Pl., Brooklyn.
Place: Squibb Hall, 745–5th Ave. Time: 8 p. m., first Monday of each month from October to May, inclusive.

### Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. Philip Romonek, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

### Ophthalmological Society of the University of Pittsburgh

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Time: Second Monday in November, January, March and May.

### Passaic-Bergen Ophthalmological Club

President: Dr. R. N. Berke, 430 Union St., Hackensack, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

### Philadelphia County Medical Society, Eye Section

Chairman: Dr. Walter I. Lillie, 255 S. 17th St., Philadelphia.
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

### Pittsburgh Ophthalmological Society

President: Dr. Edward Stieren, Union Trust Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

### Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. N. H. Turner, 200 E. Franklin St., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

### Rochester Eye, Ear, Nose and Throat Society

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

### St. Louis Ophthalmic Society

President: Dr. B. Y. Alvis, Carleton Bldg., St. Louis.
Secretary: Dr. Carl C. Beisbarth, 3720 Washington Blvd., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

### San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

### San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.
Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

### Shreveport Eye, Ear, Nose and Throat Society

President: Dr. R. R. Kirkpatrick, 6th and Walnut Sts., Texarkana, Ark.
Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

### Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. P. B. Greene, 422 Riverside Ave., Spokane, Wash.
Secretary: Dr. O. M. Rott, 421 Riverside Ave., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

### Syracuse Eye, Ear, Nose and Throat Society

President: Dr. James F. Cahill, 428 S. Salina St., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. Herbert Katz, 713 E. Genesee St., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

### Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. A. Lloyd Morgan, 170 St. George St., Toronto, Canada.
Secretary: Dr. W. R. F. Luke, 170 St. George St., Toronto, Canada.
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

### Washington, D. C., Ophthalmological Society

President: Dr. G. Victor Simpson, 1710 Rhode Island Ave., N. W., Washington, D. C.
Secretary-Treasurer: Dr. Frank D. Costenbader, 1726 I St., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.